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Incorporating Nature Magazine
Vol. LXXXII, No. 1
January 1973

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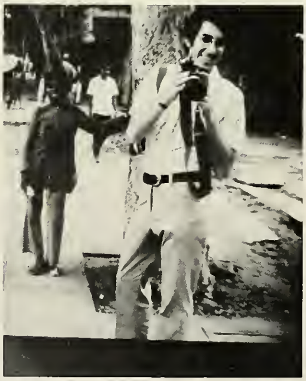
Authors

Norman Myers first became interested in conservation in his native England, where he graduated with a master's degree from Oxford University in 1957. After two years as a district officer with the Kenya administration and four as a teacher in Nairobi, he became a free-lance writer and photographer in the field of wildlife conservation. Myers, who received a doctorate in conservation ecology from the University of California at Berkeley in 1971, is now a consultant on the wildlife and human ecology of Africa. His book, *The Long African Day*, has just been published by The Macmillan Company, New York.

Norman Myers

Curtis P. Hartman

After living and studying with Vinoba Bhave in India for six months in 1968, **Curtis P. Hartman** decided to reject the fields of political science and social anthropology "to starve as a writer." He has taught in both public and private schools, but is presently studying for his doctorate in English literature at Boston University. His future plans call for a trip to Japan this summer to study chronic displacement in developing cultures. **Cary S. Wolinsky** is a free-lance photo-journalist. A graduate of Boston University, he worked for the *Boston Globe* for four years, and has been published frequently in newspapers and magazines. Wolinsky, who has traveled and worked in Ireland and India, is the author of *Marshmallow Worlds*, a book of photographs published in 1972.



Cary S. Wolinsky

Albert C. Jensen, regional supervisor of marine and coastal resources for the New York State Department of Environmental Conservation at Stony Brook, New York, holds a master of science degree in fisheries management from the State University of New York at Syracuse. From 1954 to 1966 he participated in six oceanographic cruises; in addition to writing a nature column for six years, Jensen has published numerous articles on marine subjects in scientific journals and popular magazines. He is also author of *The Cod*, a book on "the uncommon history of a common fish and its impact on American life from Viking times to the present."

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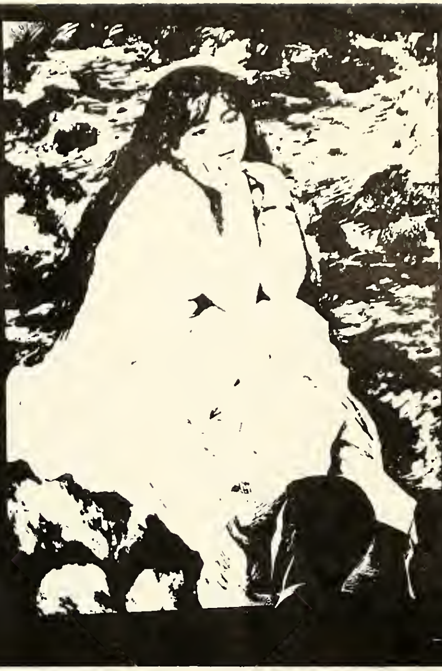

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For the past twelve years **Robert B. Brander** has studied the fisher—porcupine relationship in northern Michigan with an eye to re-establishing a state of equilibrium between these predator—prey populations. Brander, with a doctorate in wildlife management from the University of Minnesota, is the principal wildlife biologist and project leader for wildlife research in the lake states for the United States Forest Service. Coauthor of the fisher article **David J. Books**, a doctoral student in the College of Forestry at the University of Minnesota, is also a free-lance writer and photographer. His work has appeared in various conservation and camping publications.

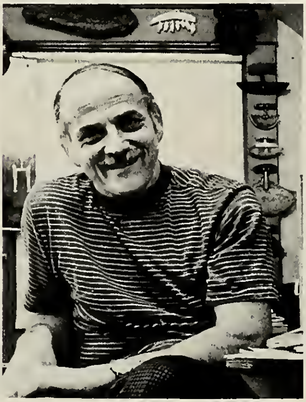
Robert B. Brander

David J. Books

Frank J. Anderson considers his frequent childhood visits to The American Museum of Natural History and the Metropolitan Museum of Art "the most valuable and lasting part of my education, a kind of off-the-sidewalk university." Anderson, a graduate of the Pratt Institute School of Fine and Applied Arts, is assistant to the librarian at the New York Botanical Garden and editor of its newsletter. He is presently engaged in a historical survey of herbal literature and a study of the relationships between art and natural history.

Frank J. Anderson

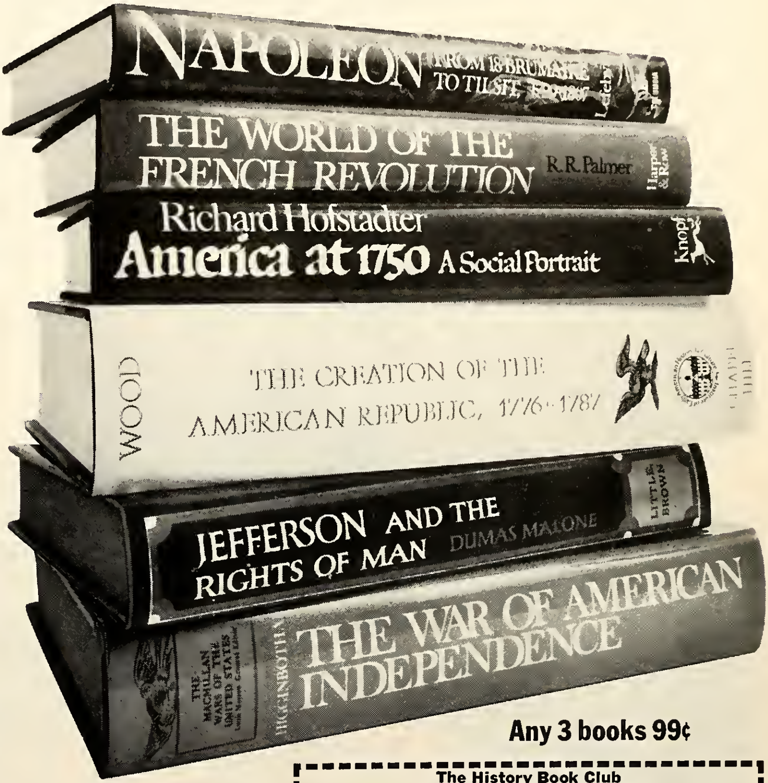
For almost thirty years **George Swinton** has studied the Eskimo and his art; particularly, the impact of modern technology on primitive art forms. Swinton, a professor at the University of Manitoba School of Art, as well as an adjunct professor of anthropology, is the author of *Eskimo Sculpture*, published by the New York Graphic Society, Ltd. He has written 82 programs for CBC-TV's "Art in Action" series and is consultant for the exhibition "Sculpture of the Inuit–Masterworks of the Canadian Arctic," which opens in Philadelphia on January 23.


George Swinton

A graduate of Cornell University Medical College, **Edwin D. Kilbourne** is professor and chairman of the Department of Microbiology, Mount Sinai School of Medicine of the City University of New York, where he continues his 22-year study of the influenza virus. Kilbourne is the author of more than ninety medical articles for technical journals and is coauthor of two textbooks: *Preventive Medicine and Public Health* and *Human Ecology and Public Health.* **Pascal James Imperato**, director of the Bureau of Infectious Disease Control and principal epidemiologist of the City of New York Department of Health received a master's degree in public health and tropical medicine from Tulane University and has done extensive field work in Africa (*see* "Nomads of the Niger," *Natural History*, December, 1972). ■

Edwin D. Kilbourne

Vacation in the 18th Century.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Letters

Indian Authors

I am very happy that *Natural History* has the good sense to include analyses of the Native American experience in its pages ("The Cheyenne Experience," November, 1972), but I'm not at all sure that what Mr. Deloria has to say about the literature covering this subject increases our understanding.

My objections come in two areas: first, his lauding of Stan Steiner's *The New Indians* and second, his implication that *Seven Arrows* marks something new in the literature of Native Americans.

I find a book such as Steiner's anything but a "real breakthrough." In fact, I find it to be a book that could do more to push interracial relations back into the nineteenth century than anything since Mohawk Trail tourist shops opened in northwestern Massachusetts. As I see it, understanding is brought about by a mutual exchange, highlighted by respect, interest, fairness, and an ability to rise above former differences.

For Steiner to quote an Indian spokesman as saying that "in the American system nothing is done legally, honestly, and truthfully" does very little to create an atmosphere conducive to dialogue, particularly since he offers no supporting evidence to back this up or even an opinion on the other side. Certainly the American system has been grossly unjust to Native Americans; to simply reiterate the outrage does nothing to correct it.

Unwarranted and unsubstantiated value judgments hurt the book from the beginning: "Going down the rough dirt road, from the earthy and easy-going tribal life on the rural reservations to the middle-class oneupsmanship of university life in the cities. . . ." Or "It was uniquely Indian: the respect for the elders by the youth; the recognition of the youth by the elders. . . ."

Orgies of racial self-denigration are the lifeblood of the book, rather than the overwhelming amount of positive material that could have been used when describing the Indians themselves: "The militant, Nazi-like Game and Fisheries Departments" or "Vacationing from the manufacture of nuclear death that was his job at the plant of the Atomic Energy Commission. . . ."

One particularly disturbing passage, which Steiner does nothing to analyze, concerned Clyde Warrior and his apparent contempt for the American "system." "If American society is so goddamn great, then how come it creates social movements like this?" questioned Warrior. A minimal acquaintance with American history would reveal a simple answer to this: America, as every other country, has had many social movements "like this" and has survived precisely because the government is highly receptive to change.

What is more constructive in my eyes, and what Mr. Deloria seems to have missed, are the many books already written by Indians in the manner of *Seven Arrows.* What of Geronimo's autobiography (published in 1906) or *Sun Chief* (the autobiography of a Hopi, published in 1942), or *The Son of Old Man Hat* (the autobiography of a Navaho, published in 1938), or Black Hawk's autobiography (published in 1833)?

These are but a few examples of exciting, immensely informative indigenous literature, which Deloria ignores when he opts for further misunderstanding and the perpetuation of myths as destructive as those his and my fifth-grade American history textbooks told.

JEFFREY A. SHEEHAN
History Department, Dublin School
Dublin, New Hampshire

The Author Replies

First, I am appalled at the misreading of my review. I commented on *The New Indians* as the real breakthrough because up until that time, no contemporary Indian had been able to write a book and have it taken seriously. I tried to write a book in 1964, and Clyde Warrior tried in 1965. Stan Steiner contacted publishers on our behalf. We were told that: (1) Indians can't write books; (2) any book written by an Indian would be biased in favor of Indians; and (3) no single Indian could represent all Indians and only impartial whites who had "studied" the question could write books on Indians.

The New Indians proved to a great many publishing houses that there were some live, articulate Indians who could conceivably write books, and so some of us were offered contracts. I wrote a book and Hank Adams has written a book. Had Stan Steiner not written his book, none of us would have ever been given a chance to write anything. I would call it a real breakthrough in terms of contemporary Indians to have the right to write our own books, saying what we wanted to say, regardless of what that message was.

I am horrified at the choice of books Sheehan quotes to show that I overlooked "Indian literature." He chose four autobiographies, the oldest of which dates from 1833 and the youngest from 1942. Certainly the world has changed considerably since 1833 and at least a minimum amount since 1942. All of these alleged autobiographies involved whites who did the actual writing with the Indians "telling their story" to a sympathetic ear. *Seven Arrows* is a book that attempts to make a religious statement in this time period. It is written without the traditional anthropological viewpoint and relates a totally new effort by Indians to make statements about today and not about what whites discovered in 1833.

With respect to Steiner's choice of words, I am not entirely happy. However, the quotations cited are certainly, in my opinion, accurate with respect to the game wardens of Washington State. Nazilike behavior is not unique to Germany of 1933–45 and if you had ever been involved in the fishing rights situation, you would see almost immediately the startling parallels. To criticize that description with-

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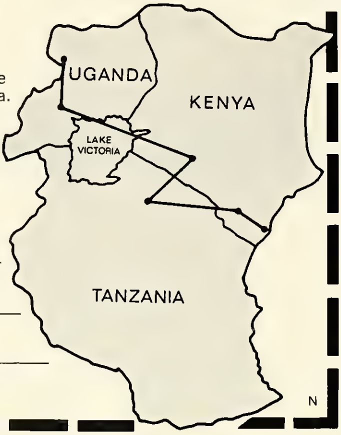

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out knowing the actual situation would appear to me to be foolhardy.

I find nothing wrong with Steiner's quotations of Clyde Warrior. Steiner was simply reporting throughout the book on what was then happening in Indian country. The recent blow-up at the Bureau of Indian Affairs would seem to indicate that Steiner early caught at least some of the mood of how people were beginning to feel with respect to their situation. I cannot see how you can be an accurate reporter on events and report only the pleasant things and hide what is really happening.

I have been keenly aware that things were building to a destructive edge in the Bureau of Indian Affairs for some time. I have done everything I could to prevent disorder, but many people attacked me for trying to stop their alleged "revolution." I am very sorry about the recent events in Washington. However, I could see this desperate "Ghost Dance" feeling coming several years ago as Indian militants began to get interested in Indian religions. I wrote the review the way I did to try and get Sheehan and millions who think like him to recognize that we are real people, that there are real and pressing problems causing great dissatisfaction, and that with the publication of *Seven Arrows* I would hope that younger Indians would recognize the strengths of their religion and cool it. I had hoped that people such as Sheehan would take seriously the problems of today and stop mooning over Geronimo, Sun Chief, and Chief Red Fox, and recognize us as contemporary people with many pressing problems.

When Sheehan demands that we all keep silent while everyone reads old autobiographies, he only helps to discredit those of us who are moderates and to fulfill predictions of militants that whites won't and can't listen.

In conclusion, I can only say that I am greatly depressed when I think that people such as Sheehan are teaching hundreds of young people American history. I believe that it is such teachers who are perpetuating stereotypes and not myself and Stan Steiner.

VINE DELORIA, JR.

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The People Crunch Comes to East Africa

A rising tide of humanity is placing the national parks under a state of siege

Africa, exotic homeland of the primitive mystique, is joining the world travel community with a rush. As air transportation makes the continent more accessible to tourists from the Western world, travel agents from Oslo to Omaha are offering trips to Africa as part of standard itineraries. Tourists are beginning to think of Nairobi as a logical extension of the Copenhagen-Paris-Rome-Athens air highway.

For tourists with raised environmental consciousness, Africa's principal attractions are its panoramic open spaces and the varieties of animals that still inhabit them. Africa is the refuge of the last great array of mammals from the Pleistocene, but their declining numbers have added a sense of urgency to the African trip. National parks, established in various areas of the continent to protect this faunal heritage, now harbor remnants of the once huge herds, as well as pocket populations of several threatened species. Much of the wildlife is found in East Africa, which has more parks and reserves than the rest of the continent put together.

Africa, however, is no longer the last great empty continent, and East Africa is fast becoming one of its most populated areas. Here, the poacher is no longer the main problem. It is the poacher's three or four surviving siblings, each with six to eight children, who are exerting the most intense pressure on the parklands and the animals inside.

Kenya, occupying some of the best of the East African wildlife country, typifies the oncoming, disastrous collision between people and animals. The annual birthrate, already high at more than 50 per 1,000 population, continues to rise, while deaths, now at 18 per 1,000, are falling at a rate of 2.0 percent per year. About half of the present population is under 16. Even if Kenya—the first country in black Africa to institute a national family planning program—were to do better than any other country has ever done and could reduce family size from an average of 7.3 children to two within the next twenty years, the population would continue to soar until the middle of the next century. The net growth rate is already approaching 3.5 percent a year, almost the highest in the world. And Kenya, along with Uganda and Tanzania, its neighboring East African nations, stands a good chance of reaching a growth rate of 4 percent annually. At this rate, its population would double in 17.5 years. The rate of the coming population expansion will be greater than Asia's and is sure to engulf much of the continent. Kenya could well feature the most extreme growth in human numbers and suffer some of the most deleterious consequences.

The monumental problems of Kenya's increasing population will be compounded by the lack of suitable land for agriculture; only one-sixth of the country's 225,000 square miles is presently arable, with an average annual rainfall of 30 or more inches. This limited area is where 90 percent of the population presently lives. But in the last few years a spillover of land-hungry Africans into the drier, game-supporting savanna lands has begun. Such is the mounting land pressure that some farmers are trying to grow maize in areas where they are lucky to get 20 inches of rain. Twenty-five years ago, when Kenya's first national parks were being set up, there were 4.6 cultivable acres for each Kenyan. Now there are two, far less than the worldwide average. Without any drop in the birthrate, there will be only 0.7 acre by the turn of the century. Even if Kenya brings its fertility rate down by a stupendous 60 percent between 1975 and 2000, unless new lands are brought under cultivation, there will still be less than one acre per person.

The 15,000 square miles of Kikuyuland—home of the Kikuyu, the nation's most numerous tribe—are already bursting at the seams, and one male out of four is trying to make a living elsewhere. Within sight of the tourist hotels of downtown Nairobi, people are living at a density of 1,800 a square mile. Farming on land almost as densely settled as the garden market areas of Holland, considered to be the most heavily occupied arable areas on earth, some of these people are subsisting through a form of unplanned horticulture. Residents of the Nairobi suburbs live at densities reaching as high as 1,000 an acre. And these people are not living in high-rise buildings, but rather in single-story huts (try to visualize 1,000 people lying down to sleep in a single acre). By the year 2000, Nairobi will be five times as big as today's tourist sees it, housing about three million

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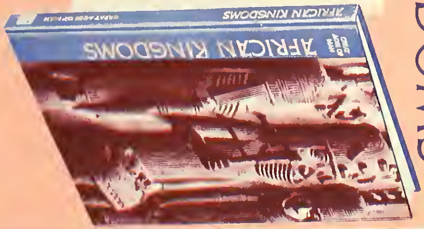

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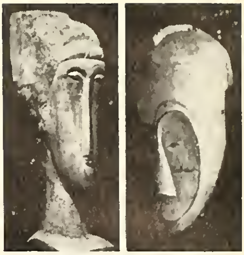
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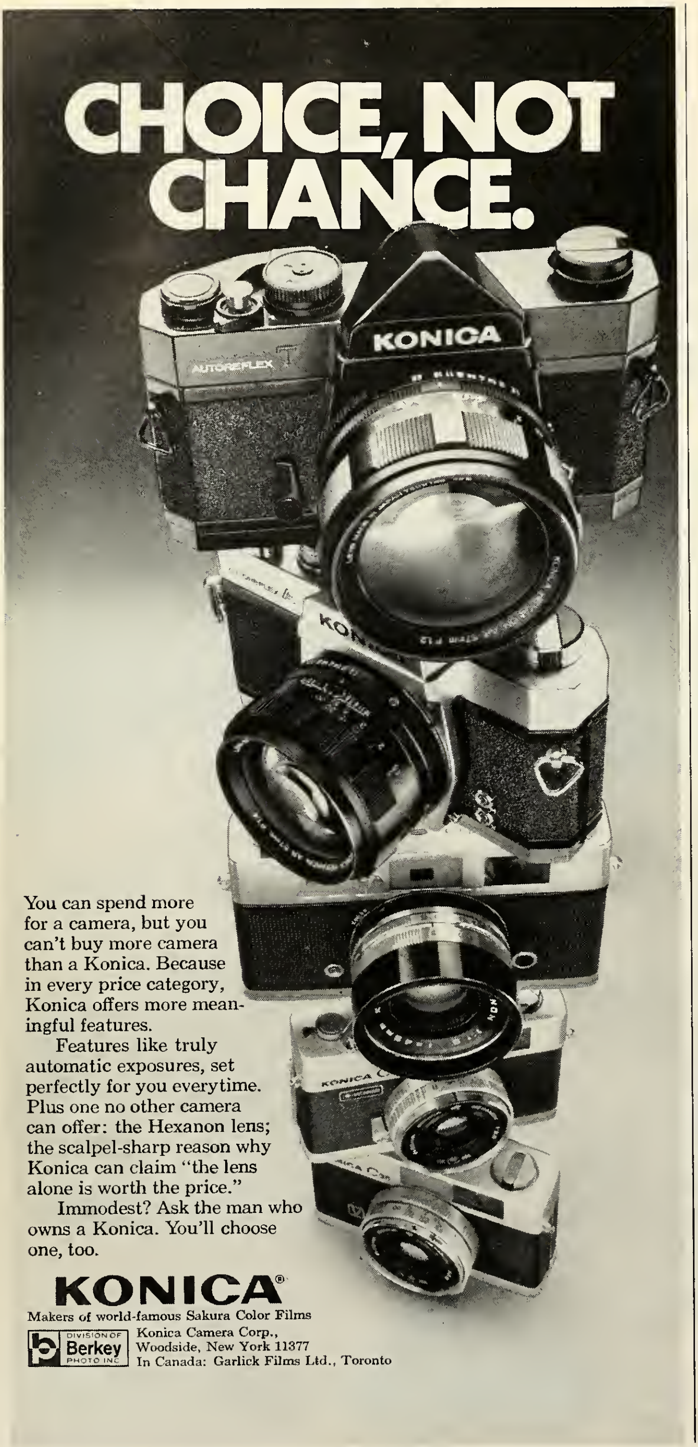

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people, many of them in slumlike settlements where it will be difficult to tell city community from overcrowded countryside.

The next generation will have to look for some patch of ground on which to scratch a living, and most of them will end up in areas not suitable for growing crops because of insufficient rainfall. One area sure to bear the brunt of the coming land search is the western part of Kenya's Masailand. This land unit, traditional grazing ground of the nomadic Masai tribe, encompasses 40,000 square miles along the Kenya-Tanzania border. Much of the area is arid savanna, moderately suitable for raising cattle in limited numbers but of little use for cultivation. The Masai rely on cattle for sur-

Huts of Kikuyu tribesmen sprawl over the arable foothills of Mount Kenya. Coffee and maize are the common crops in this area.

vival in the harsh environment, and to insure an adequate food supply, each family needs up to 100 head. The land requirements of the Masai and their cattle mean that much of Masailand becomes overpopulated at a mere six or eight people per square mile.

In the western sector of Masailand, however, wide areas with enough rain for crops are being used largely as pasture for livestock. It is hard to see the Masai resisting the expanding pressure of millions of landless people, even if the lush plains are put to the plow by the Masai themselves. Some of the best-watered sections of this high-potential agricultural land border the Mara Game Reserve, where some of the finest black-maned lions in Africa reside, and where 1,500,000 wildebeest, zebra, and gazelles from Tanzania's Serengeti Park to the south come on their seasonal migrations. Far from extending the game reserve, as would be the goal in the best of all possible worlds, it is difficult to see how it

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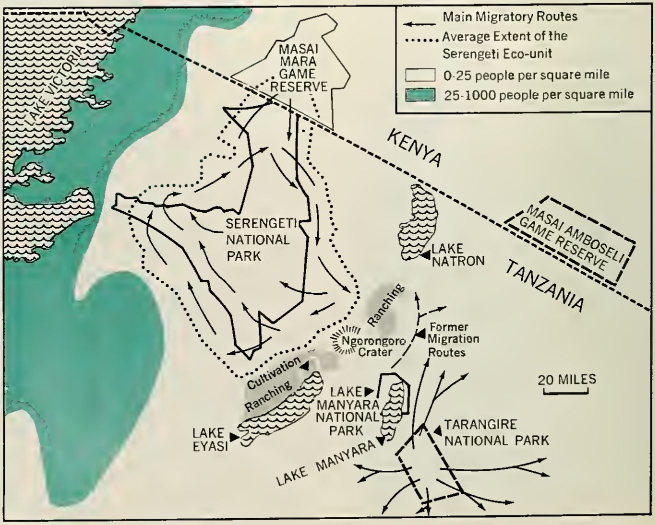
can survive with its present fecundity and spectacle in the face of all those people over the boundary. The problem will still remain even if the boundary becomes a fence, as it perhaps must if wildlife is to live next to man's growing estate. The conflict will be especially troublesome if man's estate becomes a maize plot. The farmer, watching helplessly as his harvest disappears over a game reserve boundary inside an elephant, is likely to think again about cries that Africa's wildlife does not belong to Africa alone.

Similar pressures are being mounted right now against some of the parks in Kenya. Nairobi National Park, literally on the outskirts of the rapidly expanding capital, contains remnants of the splendid herbivore herds that once roamed much of central Kenya. Modern-style Masai ranchers are now starting to fence off the migration routes of the animals onto the Athi Plains of Masailand. Resident herds of semidomestic animals could soon be the inevitable result as the park is transformed into a large outdoor zoo.

Animals do not remain within the confines of parks. During the wet season, many from Tarangire National Park migrate through an area ten times the size of the park, while in drought years, the Serengeti eco-unit extends to Lake Eyasi. As agricultural activities usurp these unprotected areas, only a reduced number of park animals will survive.

Tsavo National Park, in the southeast section of the country, is one of the largest in the world, but still too small at 8,000 square miles (twice the size of Yellowstone National Park) to absorb the numbers of elephants crowded into the sanctuary of the park by the expansion of nearby tribes. Since World War II, human population densities in the environs have increased by up to 100 percent. In the Taita Hills overlooking the park, the local community has doubled and the amount of land under cultivation has trebled: not only are people's numbers rising but their expectations as well, and a man may not be content with the amount of land his father subsisted on.

This also means that some steep slopes are being dug up, and erosion is rapidly accelerating. The Voi River, which used to bring relief to Tsavo's parched elephant ranges during the dry season, now dries up soon after the rains peter out. Other large rivers of Kenya, such as the Galana, now carry so much topsoil from overworked arable regions hundreds of miles



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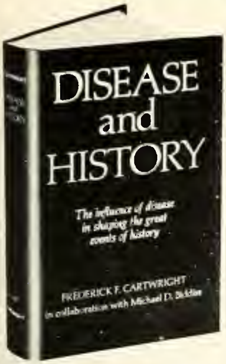
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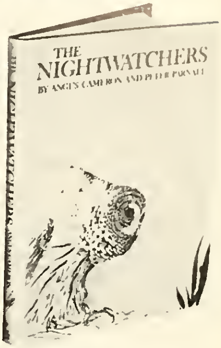

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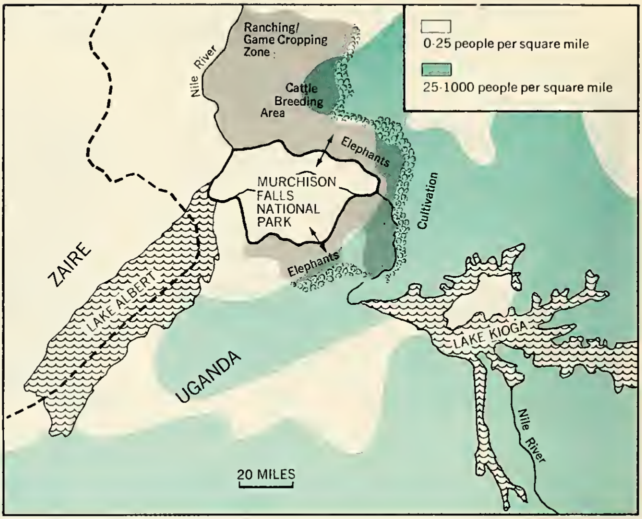
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Nile River
20 MILES

Elephants are being increasingly restricted to areas like Murchison Falls National Park, where they are trapped in what is, in effect, a large outdoor zoo.

inland that the new marine parks on the coast, where the Galana River debouches into the Indian Ocean, are threatened with suffocation by silt.

The situation in neighboring Tanzania is not yet as bad. The 14 million residents occupy a land of 363,000 square miles, an area the size of Texas. Approximately a third of the country is nearly uninhabitable because of heavy infestation by the tsetse. Also, much of central Tanzania is too arid for cultivation, and the cost of irrigation would be prohibitively high. There is already heavy population pressure in several areas. Under the country's present level of technology and market mechanisms, almost one-quarter of the land area can be considered overpopulated, and another one-third at saturation level. Every district around the great chain of parks and wildlife areas in the north, including Serengeti, Ngorongoro Crater, Lake Manyara, and Tarangire, falls into either of these two categories.

Tanzania's infant mortality rate is still at the appalling level of 165 per 1,000, a rate that provides plenty of scope for cutting down on human loss and for pushing up population growth higher than the present 2.8—3.0 percent. President Julius Nyerere has emphasized that this flood of people could well hold up the type of development he wants to see for the country, but little official has been done in the way of family planning, and abortion is widely condemned.

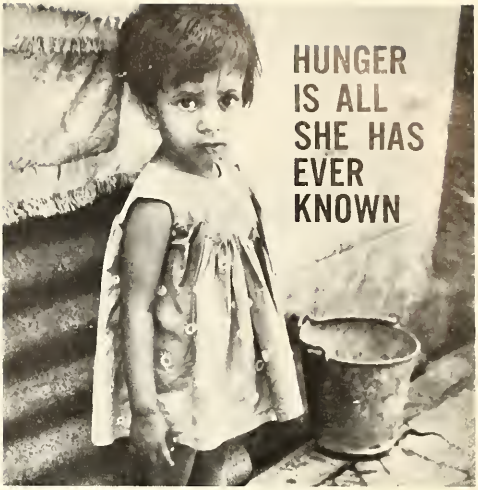
The area to the west and northwest of the Serengeti National Park is among the most densely occupied in the whole country. Grass huts and maize plantations line much of the park's boundaries and clog the strategic migration routes of the wildebeest and zebra. In fact, the park, as it is now constituted, is only a half or a third the size of its eco-unit. The size required by the migrating animals shifts from season to season according to the annual rainfall: in 1970, the wildebeest strayed twice as far outside the park as they had two years before. During the 1960s, park officials managed, through strenuous efforts, to get extra bits of territory added to the sanctuary. But those days are over. In early 1972, a 60-square-mile sector of parkland was occupied by local people with the blessing of their adminis-

Continued on page 79

The answers to some questions frequently asked by our sponsors

If you are considering sponsoring a child through the Christian Children's Fund, certain questions may occur to you. Perhaps you will find them answered here.

Q. **What does it cost to sponsor a child?** A. Only $12 per month. (Your gifts are tax deductible.)
Q. **May I choose the child I wish to help?** A. You may indicate your preference of boy or girl, age, and country. Many sponsors allow us to select a child from our emergency list.
Q. **Will I receive a photograph of my child?** A. Yes, and with the photograph will come a case history plus a description of the Home or Project where your child receives help.
Q. **How long does it take before I learn about the child assigned to me?** A. You will receive your personal sponsor folder in about two weeks, giving you complete information about the child you will be helping.
Q. **May I write to my child?** A. Yes. In fact, your child will write to you a few weeks after you become a sponsor. Your letters are translated by one of our workers overseas. You receive your child's original letter, plus an English translation, direct from the Home or Project overseas.
Q. **What type of Projects does CCF support overseas?** A. Besides the orphanages and Family Helper Projects CCF has homes for the blind, abandoned babies homes, day care nurseries, health homes, vocational training centers, and many other types of Projects.
Q. **Who supervises the work overseas?** A. Regional offices are staffed with both Americans and nationals. Caseworkers, orphanage superintendents, housemothers, and other personnel must meet high professional standards—plus have a deep love for children.
Q. **Is CCF independent or church operated?** A. Independent. CCF is incorporated as a nonprofit organization. We work closely with missionaries of 41 denominations. No child is refused entrance to a Home because of creed or race.
Q. **When was CCF started, and how large is it now?** A. 1938 was the beginning, with one orphanage in China. Today, over 150,000 children are being assisted in 55 countries. However, we are not interested in being "big." Rather, our job is to be a bridge between the American sponsor, and the child being helped overseas.
Q. **May I visit my child?** A. Yes. Our Homes and Projects around the world are delighted to have sponsors visit them. Please inform the superintendent in advance of your scheduled arrival.
Q. **May groups sponsor a child?** A. Yes, church classes, office workers, civic clubs, schools and other groups. We ask that one person serve as correspondent for a group.
Q. **Are all the children orphans?** A. No. Although many of our children are orphans, youngsters are helped primarily on the basis of need. Some have one living parent unable to care for the child properly. Others come to us because of abandonment, broken homes, parents unwilling to assume responsibility, serious illness of one or both parents, or parents just too poor to care for their children.
Q. **How can I be sure that the money I give actually reaches the child?** A. CCF keeps close check on all children through field offices, supervisors and caseworkers. Homes and Projects are inspected by our staff. Each Home is required to submit an annual audited statement.
Q. **Is CCF registered with any government agency?** A. Yes, CCF is registered with the U.S. State Department's Advisory Committee on Voluntary Foreign Aid, holding Registration No. 080.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by Marvin Harris

What Goes Up, May Stay Up

A 300-year-old cycle of ups and downs in Western women's fashions has been shattered—despite the designers

I have been watching the amount of leg exposed by the ups and downs of women's dress fashions since 1949. That was the year I took a course given by the great anthropologist Alfred Kroeber entitled "The Nature of Culture." Kroeber was then the leading advocate of the theory that cultural patterns have a life of their own, independent of the actions and plans of prominent individuals.

Because it had shock effect, women's dress was Kroeber's favorite example for proving this theory. Fashion experts thought that women's fashions were "set" by a small number of Parisian designers and their wealthy customers. They subscribed to the still popular view that of all cultural phenomena, dress styles are the most fickle. Virtuoso designers are supposedly free to do as they please, raising or lowering hemlines, shrinking or expanding waists, covering or exposing the bosom, according to the happy fancy of inspired genius.

At the time that Kroeber published his first study of dress styles in 1919, Chanel was the reigning designer. Before her it had been Poiret, father of the "hobble skirt." So charismatic were these geniuses of fashion that during World War I, the leading Paris houses continued to dictate style not only in London and New York but in Berlin and Vienna as well.

Kroeber was primarily interested in debunking the role of the virtuoso designers. He saw them, not as "style setters," but as agents of cyclical trends over which they had little real control. According to Kroeber, dress styles were obedient to a basic pattern that perdured independently of the conscious whims and schemes of the designers.

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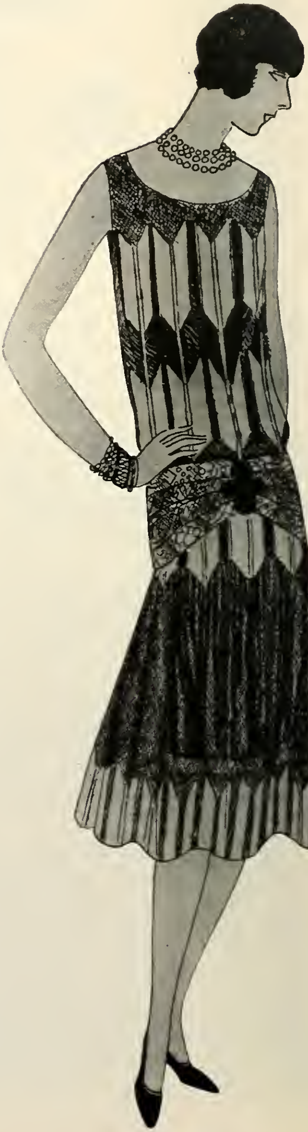
In 1940 Kroeber and anthropologist Jane Richardson published a study that concluded that the basic pattern of Western women's dresses (for evening) had been remarkably stable for more than 300 years—from 1631 to 1936—all impressions of sensational novelties such as hoops, bustles, and short skirts notwithstanding.

Kroeber concentrated on six dimensions to prove his point: skirt length, skirt diameter at base, waist height, waist width, depth of décolletage, and width of décolletage. Until 1936, the last year investigated, these dimensions fluctuated in an orderly manner, going from one extreme to another—and returning again—on an average of every 98 years. For example: skirts were full in 1655, narrow in 1679, full in 1750, narrow in 1811, full in 1861 and narrow in 1926. Waists were high in 1720, low in 1760, high in 1817, low in 1842, high in 1869, low in 1903, high in 1917, low in 1926. Each of the remaining measures had its own periodicity. The precise wavelength was not important; what was important was that as each dimension departed further from a certain normal value characteristic of the pattern, the probability that it would reverse direction increased.

Which value was the normal one corresponding to the basic pattern? The thin or thick waist? The high or low neckline? The long or short skirt? Kroeber solved this problem by measuring the variability in the year-by-year samples. If dresses showed a large amount of variation at one extreme but not at the other, he concluded that the basic pattern was the extreme with the smaller amount of variation. If both extremes had high amounts of variation, the middle values were selected. For example, the narrower the waist and the fuller the skirt, the less variation per sample of dresses per year.

By analyzing the relationship between variances and the long-term maximum and minimum measurements, Richardson and Kroeber arrived at a definition of what they called the "basic or ideal pattern of Occidental women's evening or formal dress":

Poiret took the dress to the knee in 1926: low waisted, loose, and liberated. But hemlines were to fall with the market in 1929.



long skirt, ample at bottom; an expanse of bare breast and shoulders, as deep and wide as possible (subject only to "mechanical" limitations); as slender a waist as possible; and a middle, or natural, waistline position.

Although Kroeber and Richardson emphasized that they were analyzing evening or formal wear, their conclusions were applicable to daytime attire worn by women who were wealthy enough to follow the fashion. So the pattern described above can be considered to apply equally to day and evening wear at least until 1900. For the years since 1900, annual day-wear modes are easily substituted for Kroeber's evening wear measurements.

I want to devote the remainder of this essay to the proposition that the basic pattern of Western women's dress—day and evening—had actually begun to break up in 1913 before Kroeber wrote his first article. Today, we are deep into a transitional period in which further pattern-shattering changes can be expected. I base my opinion on the unprecedented behavior of skirt length during the present century.

Prior to 1913, skirt length was the least variable of the six basic dimensions investigated by Kroeber and Richardson. The basic pattern was not simply a "long skirt," but a skirt that remained at the ankle or the ground continuously throughout its entire history. The only exceptions were the years 1813 and 1834 when skirts rose briefly and erratically to a point between the ankle and calf. Starting in 1913, however, daytime skirts rose to the ankle and have never returned below it, in spite of repeated attempts by designers to get them back into their timeworn groove between the ankle and the floor. Between 1913 and the present, all ups and downs have taken place above the ankle. According to the measurements of fashion author Helen L. Brockman, skirts reached the calf in 1918, fell to the ankle by 1922, rose to the knee in 1927, fell to the ankle in 1929, hovered between calf and ankle from 1930 to 1938, and rose to the top of the calf by 1940. During World War II they held steady at the top

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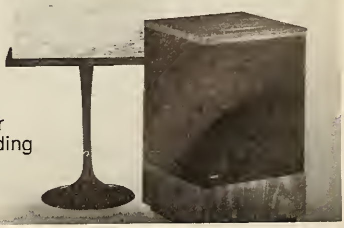

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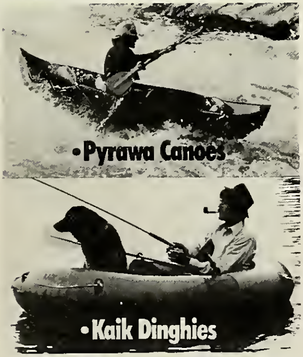

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of the calf only to drop back to the ankle in 1947. In 1950 they started up again, regaining and holding the World War II top-of-calf levels from 1958 to 1960.

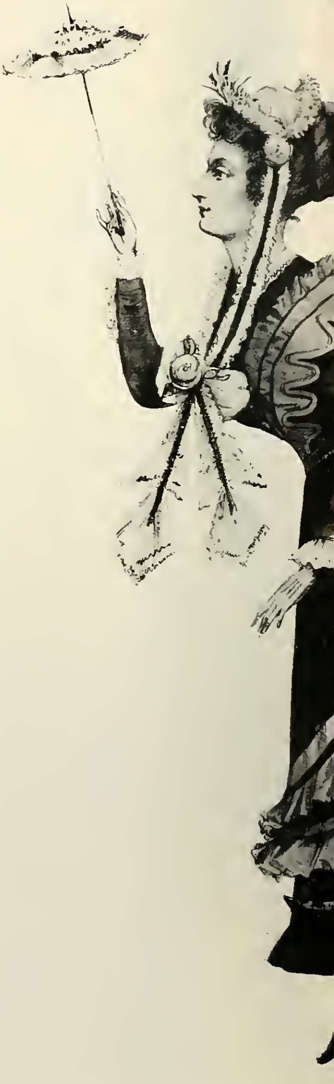
In the early 1960s confusion reigned as skirts started to rise above the knee. Some designers pinned their future on the continued upward advance, while others held steady below the knee. In 1960 *Vogue* magazine said "no" to skirts three or four inches above the knees, implying that one or two inches above was not unthinkable. In 1963 *Vogue*'s editor-in-chief capitulated to the upward movement and advised women to settle for "the shortest possible skirts." By 1967–68, this meant miniskirts, four or five inches above the knee.

Simultaneously, midi- and maxiskirts were launched by designers who were, in effect, betting that Richardson and Kroeber's basic pattern still existed and that there must inevitably be a return to the ankle and below. The climactic shattering occurred in 1968–1969 when *Vogue*, noting the existence of long and demi-long as well as minilengths, declared, "We are past being hung up on hemlines." An editorial on September 15, 1969, wrapped it all up: "Every woman should choose her skirt length or lengths. No need to stick to one. Don't worry about length at all. No length is more correct than any other. Be comfortable, be happy. Paris is filled with uncomplications."

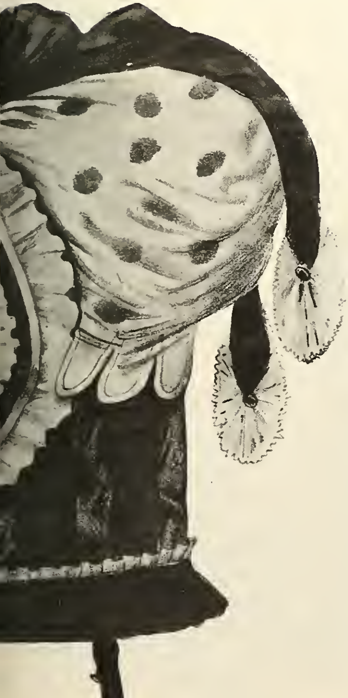
Kroeber and his coauthor had made no provision for skirts above the knee. During the midilength 1930s it appeared to them that "the upper limit of possibility, and probably our less definable limits of decency" had already been reached in 1927 at the knee. They were right in one sense: by surging over the knee the basic pattern had oscillated itself right out of existence. While there may yet be a return to maxilength for evening wear, other lengths will remain as alternatives. For daywear, dresses and pants ranging from mini and short-short to maxi and long trousers will probably be found in the same wardrobe for a long time to come.

I predict that Occidental women will never again tolerate a fashion that requires them to wear ankle- to floor-length skirts except as entirely optional alternatives to pants or short skirts. The demise of the floor-length skirt is the Occidental equivalent of the end of foot binding in China or of veil wearing in the Middle East. It is a significant victory in the struggle for women's liberation.

Although Kroeber thoroughly



misunderstood the significance of the skirt-length highs of 1918 and 1927, his main point about the causes of style changes seems to be more valid than ever. Large-scale cultural forces, rather than the designers, are in control of fashion changes. Unless you believe that women's liberation is a movement primarily based in the French houses of fashion, you will



The well-dressed woman of 1868 was more tortured than liberated. This Currier and Ives cartoon poked fun at the bustle.

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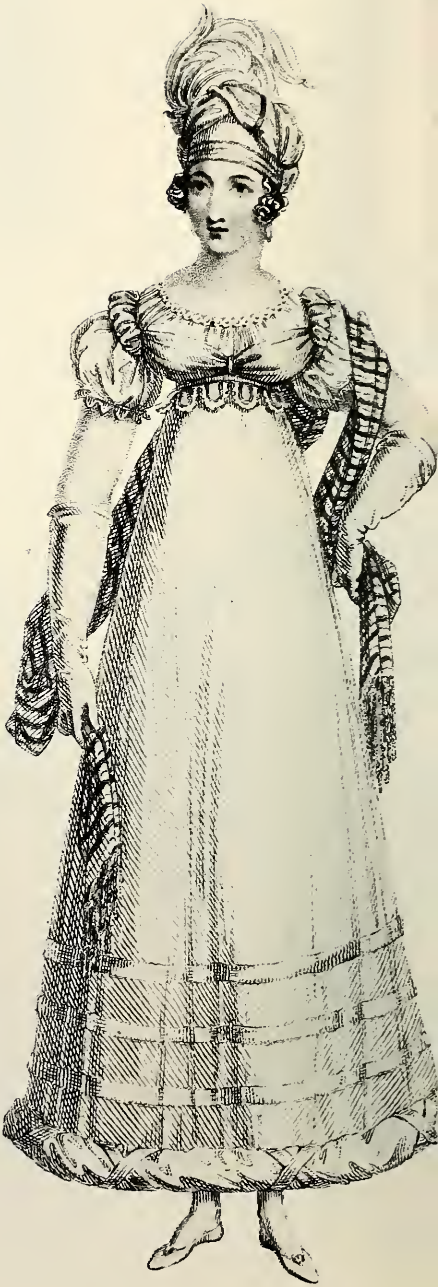
The Empire dress of 1818 was high waisted, slim skirted, sweet simplicity (in Josephine's time the neckline swooped considerably lower). Just 40 years later hoops became the rage.



have to concede that the bright young designers of 1962 who took the skirt above the knee were responding to an opportunity they had done little to create.

If my analysis is correct and the basic pattern of Western women's dress has indeed been shattered, certain additional consequences logically follow. I will be surprised if some of the other time-honored limitations on Occidental female attire are not also superseded in the near future. For example, the traditional pattern of décolletage is already under attack. Kroeber and Richardson wrote about the mechanical limitations that prevented the simultaneous achievement of maximum depth and breadth in the exposure of the upper torso, but see-through fabrics provide an easy, technical solution to this problem. An informant tells me that extensive "transparencies" will also shortly be in the fashion news. To the extent that a double standard has prevailed by which women can be arrested for exposing their breasts in public, while men suffer no such restrictions, toplessness is a liberationist issue. Hence, I do not expect the taboo on female breast exposure to be maintained much longer.

The breaking of these centuries-old patterns will not lead, as some hope and others fear, to an era in which "anything goes." New patterns will simply take the place of the old, and styles will resume their meandering within culturally defined channels. Even in societies that have stripped down to penis sheaths and G strings, strict limits of exposure continue to exist. Culturally established preferences, mainly unconscious, will continue to channel our own post-liberation choice of clothing and adornment. I do not, for example, expect men to begin wearing skirts this year. Neither sex will cover up with lip plugs, nasal septum feathers, facial tatoos, or body cicatrices. A runner from Seventh Avenue has just reached me with the news I know you've been waiting for: tooth avulsion and tooth blackening are definitely "out" in 1973.

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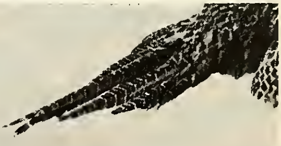

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The Language of the Leaves

To learn how and why plants move their leaves, ask a plant

For those who would divine some of the inner secrets of plants, the leaves speak a language of their own. Learning to read and speak this language is a challenge worthy of the most highly developed skills of the experimental biologist; learning to frame critical questions and ask them of the plant in such a way as to elicit a clear answer is exhilarating. I speak from experience, for some colleagues and I have been engaged in this kind of dialogue for about five years now, and the answers we receive from the plant keep us busy devising ways to ask still more questions.

Let us start with the observation that many leaves have obvious sleep movements: during the day, the leaves are so oriented that the lamina, or blade, is roughly perpendicular to the incident sunlight, and is thus said to be in an upright, or "awake," condition. By contrast, at night the leaves frequently fold so that their blades face either other leaf blades or the stem of the plant. (*See* "The Rhythm of the Flowers," by John D. Palmer, *Natural History*, August-September, 1971.) It is easy to understand why leaves should be oriented with their blades perpendicular to the incident light during the daytime: the leaves are, above all, photosynthetic organs and the horizontal orientation optimizes light absorption for this important nutritional process. But why should a leaf fold at night? Why go through the trouble of a cycle of closing and opening when it would be less complicated simply to stay open and be ready to receive the next morning's sunlight?

Most people believe that all characteristics of living organisms must have some survival or selective value, or else they would have been eliminated in the long course of the evolution of those organisms. In fact, Charles Darwin, who was fascinated by plant movements in general, and especially by leaf movements, hypothesized that the inward folding of leaves at night prevented excessive radiative heat loss to the open sky. Since, on a clear night, the open sky is a "black-body" absorber with an effective temperature of absolute zero, and since heat loss by radiation is proportional to the fourth power of the absolute temperature difference between sending and receiving body, such heat loss could cool the plant down drastically. For tropical plants, whose metabolic processes are geared to work best at high temperatures, this could be a serious impediment to growth. Thus, folding of the leaves at night, according to Darwin, is simply a device employed by the plant to protect itself against excessive radiative heat loss.

For about 80 years this was the only theory that seemed at all reasonable, and it was accepted simply for lack of an alternate explanation. Recently, however, another plausible theory has been advanced by the distinguished German plant physiologist Erwin Bünning. Bünning and his colleague Moser noted that a necessary stimulus to flower formation in many plants with pronounced leaf movements is the so-called short-day treatment. In reality, the leaves of such "short-day" plants need an uninterrupted long night of a certain minimum duration before they start to synthesize and export the flower-forming hormone that transforms their buds from vegetative to reproductive structures. The plant is so sensitive to light during this mandatory dark period that even the intensity of bright moonlight could inhibit production of the hormone.

How, then, can such photoperiodically sensitive plants time their flowering efficiently when the erratic effects of moonlight might disturb them? The answer, said Bünning and Moser, is that the leaf-folding process causes the plant to present the narrow edge of their blades to the impinging moonlight; this minimizes light absorption to the point that the chemical processes requiring darkness can proceed without interruption. In long-day plants, which require short nights for flower formation, the same mechanism would prevent premature reproduction.

Which theory is more nearly correct, Darwin's or Bünning's? It is hard to say, although Bünning's has an appeal in that it bases the plant's movements on a more qualitatively important decision. To make a flower or not seems to be a more important question than whether to cool down markedly or not. For some tropical plants the latter decision may be crucial, but even many temperate plants have pronounced nyctinastic (sleep) movements. At the moment, it seems most appropriate to concede that both theories have a certain validity.

What is the mechanism that causes the leaves to move? Certainly not muscles, which do not exist in plants, although contractile proteins do exist within plant cells. This question is most conveniently studied in certain leguminous plants whose leaves are attached to the stem by a special organ called a pulvinus. This swollen knob of tissue contains special motor cells on its upper and lower surfaces; such cells are capable of shrinking and swelling dramatically in response to loss and gain of water. This, in turn, is governed through regulation of the salt concentration of the stor-

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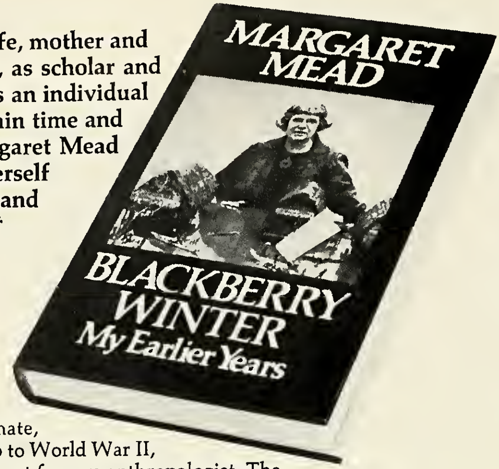

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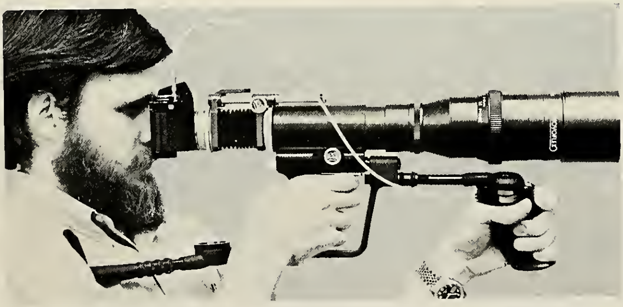

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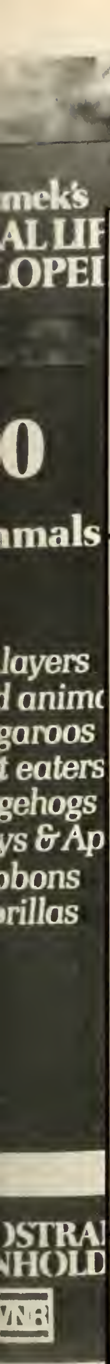
age compartments, or vacuoles, of these cells. When the salt concentration of these cells is increased, their osmotic concentration becomes sufficiently high that water tends to diffuse into the cell, thereby increasing its internal turgor pressure and making it bulge and swell. When salt is lost from such motor cells, the osmotic concentration declines and water tends to diffuse out, the internal pressure declines and the cell becomes flaccid and shrinks.

Thus, when the upper cells are turgid and the lower cells flaccid, the leaves are pushed down and out from the stem to the horizontal, or "awake," position. When, on the contrary, the lower cells are more turgid than the upper cells, the leaf is pivoted at the pulvinus and pushed upward and toward the stem, assuming the closed, or "asleep," attitude. Thus, leaf movements are accomplished by differential salt accumulation patterns, which in turn control the diffusion of water into and out of key motor cells in the pulvinus.

What controls salt movement into and out of the motor cells? One obvious answer is the alternation of light and dark. In fact, one can easily show that many darkened, asleep leaves will open promptly upon illumination; the opening is accompanied by a marked increase in the salt concentration of the upper motor cells. Conversely, many illuminated, awake plant leaves will close promptly upon transfer to darkness, and this is accompanied by a loss of salts from the upper motor cells and a gain of salts in the lower motor cells.

In the plant we have studied most intensively, the leguminous silk tree, *Albizzia*, the mobile element is potassium, probably moving across the membrane as the salt of an organic acid, such as malic acid (so named because of its abundance in the apple, *Malus*). Both the uptake and secretion of potassium salts from upper motor cells of the pulvinus involve the expenditure of energy, indicating the operation of a metabolically powered potassium "pump" located in the membrane. Thus, in the upper motor cells the inwardly directed pumps pre-



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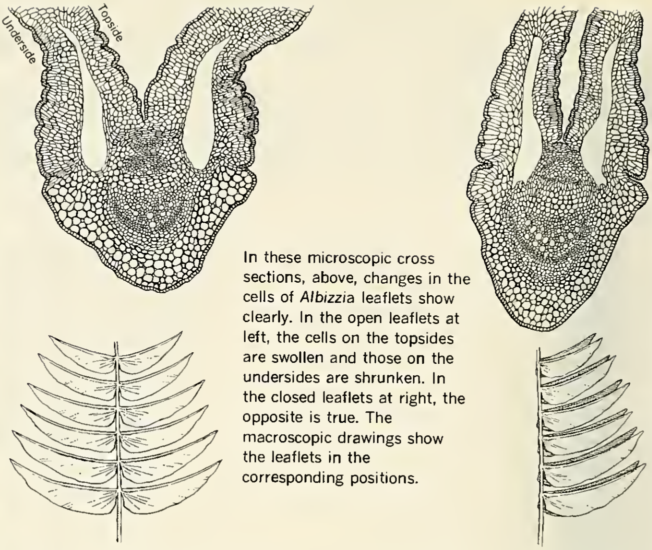

In these microscopic cross sections, above, changes in the cells of *Albizzia* leaflets show clearly. In the open leaflets at left, the cells on the topsides are swollen and those on the undersides are shrunken. In the closed leaflets at right, the opposite is true. The macroscopic drawings show the leaflets in the corresponding positions.

dominate in the light; the outwardly directed pumps, in the dark.

But this is far from the whole story. If a leaf is artificially maintained in continuous light for an unusually long period, the leaf closes, even in bright light. Conversely, if a closed leaf is maintained in an extraordinarily long dark period, it will open spontaneously. The closing and opening movements of leaves maintained under constant conditions will occur at roughly twelve-hour intervals, so that the complete cycle takes about 24 hours, or one day. Such rhythmically repeated events, with an oscillatory frequency of about one day, are said to be circadian. When the circadian rhythm persists under constant environmental conditions, it is said to be endogenous. Thus, the leaf movements of many plants show control both by light and by some as yet uncharacterized endogenous, circadian process.

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Land Sharing in Rural India

Inspired by a holy man, some farmers are pooling their resources to combat drought and hunger

by Curtis P. Hartman

photographs by Cary S. Wolinsky

This winter the seventy-three people of Nazrichawk, a village in the Indian state of Bihar, are faced with famine. The monsoon rains came too late last summer, and crops across the state withered. Fifty percent of the maize died, and because of insufficient water in the paddies, only 30 percent of the annual rice crop, the area's staple food, could be planted. Crops in the lowlands, which caught water running down from rocky hills common in many areas of the state, grew well, but for each productive field, four went unplanted.

After the last drought, in 1967, government and private agencies constructed a concrete irrigation project—complete with diesel pump—capable of lifting enough water from a nearby river to flood ten acres of rice paddy a day. A local government development worker hailed the construction as "ending forever the threat of drought in Nazrichawk." Now the inch of brackish water in the irrigation

Runoff from nearby hills barely provided enough water for transplanting rice in this Bihar paddy last year.

ditch is a breeding ground for frogs. The diesel pump, unused and unmaintained, is encrusted with rust. The paddies surrounding the project, which should be shimmering and emerald, are brown and fallow.

For $100, a large but not impossible sum for a small village to raise, the community could have repaired and operated the pump when it was finally needed. Unfortunately, leaders of Nazrichawk's different caste groups could not agree on a pattern for water distribution and a loan was never taken.

The situation in Nazrichawk illustrates the complex of problems that frustrates rural development throughout Bihar. Schemes to raise crop productivity by means of irrigation systems, new strains of rice, and various planting techniques have been tried over the years. All have failed.

Weather is a major problem. Only five times in the last twenty years has Bihar received the right amount of rain at the right time. During the other fifteen years, agonizing labor with hand-crafted implements produced only a subsistence crop for the few who could afford seed. Irrigation waters less than 3 percent of the tillable land in Bihar; the men who farm the balance of the land remain tied to the erratic monsoon rain.

Yet the soil is rich. If erosion could be halted and the acreage under irrigation increased, the agricultural productivity of Bihar could be increased more than 200 percent. The problem is that the necessary work projects would require a group effort: to develop schemes any more sophisticated than a bullock-drawn waterwheel demands consensus on such issues as water distribution, financing, and labor.

Such common needs, however, rarely unify a community divided by religion, caste, and politics. Moslem-Hindu rancor, which caused India's partition in 1947, still simmers in many rural areas, and while the national government is scrupulously secular, the widespread rioting that exploded this past June in the state of Uttar Pradesh indicates how little of this spirit reaches beyond the capital of New Delhi.

In numerous villages, caste divisions are an even greater hindrance than religious differences to the consensus necessary for rural development. While most of the traditionally supportive aspects of the caste system disappeared after 200 years of British rule and 25 years of independence, a strong residual system of social stratification persists. Incidents in

Top left: The village council, or gram sabha, *of Kiriah, in session. Above, Vinoba Bhave meets with followers at his ashram. The empty irrigation ditch of Nazrichawk, left, runs through a field of drought-stunted maize. In preparation for transplanting rice, far left, a man works the paddy field with a bullock-drawn plow.*

which low-caste individuals are stoned for drawing water from a high-caste well are frequent, and even such simple acts as intercaste dining remain taboo in many villages. A multitude of small, caste-oriented political parties are active throughout the state, and their activities further fragmentize the villages. Instead of being a community, a village often disintegrates into hostile factions splintered along religious, political, and caste lines.

There is also the problem of obtaining financing for development projects. Few lending institutions in either the public or the private sector are willing to grant credit to a small community, and most farmers in need of cash are forced to sell their land and become migrant or tenant laborers. Rarely is there any local industry that is capable of either cre-

The faces of rural Bihar.

ating a capital base or of offering casual employment.

Eighty percent of India's burgeoning population is rural, and any hope for the progress of this group will depend upon development programs. Ironically, it is in Bihar, one of the poorest states in India, that a development strategy offering positive hope for such improvement has been growing for almost twenty years. The strategy, or movement, has been named *bhoo-dan,* "land gift."

Essentially a nonpolitical structure for the mobilization of local effort to meet specific development needs, *bhoo-dan* is not a concept that emanated from one of India's many bureaucratic planning boards; rather, it developed out of the experiences of a now frail 77-year-old man, Vinoba Bhave.

Vinoba is a unique figure on the contemporary Indian scene. He is not affiliated with any political party, and has never sought public office. Yet he is as well known in rural India as was Gandhi, who also avoided electoral politics. During the long freedom struggle, Vinoba was Gandhi's foremost disciple, and now most people consider him the mahatma's spiritual heir. As such, he inherited Gandhi's mantle of saintliness. The saint, a traditional Indian figure, is a spiritual leader who ex-

At an Independence Day celebration organized by gram-dan *workers, young boys participate in a rice-transplanting contest. Judging is based on speed and neatness, but after the fun, it is the women of the village who will do this tedious work. Youngsters, below, play* kopatty, *a traditional Indian game that combines elements of wrestling and tag.*

emplifies austere renunciation coupled with service to others. Vinoba took a vow of celibacy at the age of ten; at seventeen, a vow of poverty; and at twenty-four, a vow of service to others. To the villagers who flock to garland him with flowers he is a saint—a perfect, selfless man.

In 1952 Vinoba was invited to address a conference of Gandhian workers in the state of Telengana, some 350 miles from the ashram, or retreat, where he had been in meditation for the four years since Gandhi's death. Hoping to re-establish contact with India's rural population, Vinoba walked the entire distance. In most of the villages along the way, he was received as a great teacher; individual villagers sought his assistance, and entire communities attended his nonsectarian prayer meetings.

In one village, Pochampalli, he was approached by a representative of a group of twenty-two landless families of the untouchable caste—the lowest stratum of Indian society. Without land, the man said, the families would starve. During that night's prayer meeting, Vinoba spoke of the obligation of each villager to aid his neighbors. "These people are your brothers," he said. "Are they to have no land?" One wealthy landowner at the back of the gathering stood up. If Vinoba wished, he announced, he would give them 100 acres.

This was the beginning of the *bhoo-dan* movement; over the past twenty years, walking thousands of miles from village to village, Vinoba has collected more than 3½ million acres of land gifts to be distributed to India's landless. His success, in a country where land is the primary commodity of value, was due only to his reputation as a saintly teacher unmotivated by personal concerns. As he walked, he gathered disciples: primarily youths from urban and semiurban high schools and colleges. They would remain behind in the villages through which he passed to implement the pledges and redistribute the land. In one community in 1956 all of the landowning villagers decided to give their properties to Vinoba. He returned the gift; all of the land, he declared, should be held by the village as a whole. This was the first *gram-dan*, or "village gift."

While Vinoba avoided creating any external structure for *bhoo-dan* and *gram-dan*, an organization of his disciples, the Sarva Seva Sangh, developed as the number of gifts and the number of disciples grew. Once again in meditation, Vinoba is no longer walking, but the disciples have become organized and independent workers. More than 5,000 *gram-dan* workers are laboring full time throughout rural India.

A small number still walk from village to village, spreading Vinoba's doctrine of sharing, brotherhood, and self-sufficiency. The majority of them, however, have set up base operations at self-sufficient ashrams on *bhoo-dan* land in heavily populated village areas. Most ashrams function as part-time local schools and as central meeting places for villagers throughout the area. While the workers continue to spread the *gram-dan* doctrine, most of them are more concerned with the lengthy process of pledge implementation and with rural development in general in the surrounding villages: digging wells, arbitrating community disputes, and introducing new seed and planting techniques occupy most of their time.

The actual operation of the *gram-dan* process is relatively simple. Each landowner agrees to turn legal title to his property over to the village as a whole. Twenty percent of this land is leased, rent free and in perpetuity, to all landless members of the village. The remaining 80 percent of the land is leased back, on the same terms, to the original donor. Each villager then agrees to give one-thirtieth of his yearly income (the equivalent of one day a month's intake) in cash, produce, or labor to a central fund. All villagers become members of a council, which by near-unanimous consent makes all community decisions.

As soon as implementation begins, the problem of landlessness disappears; with the distribution of 20 percent of all lands, each family is assured of at least a small plot. And large landholders rarely feel threatened. If a man owns ten acres before *gram-*

To supplement a meager income, a gram-dan *villager separates long strands of cotton preparatory to weaving* khadi, *the traditional Indian cloth. Another villager, without land to farm, has foraged these sticks to sell as firewood.*

dan, for example, he will still retain the use of eight acres after the conversion. Although he cannot sell the land without the approval of the village council, the all-important farming rights remain with the original owner and his heirs. The stipulation against sale insures that legal title, as well as farming rights, stays in the village rather than going to an urban moneylender. In most cases the existence of the central fund makes the sale of any land unnecessary. The collection of one-thirtieth of each villager's yearly income or produce guarantees that a community will have a capital base.

The village council, or *gram sabha*, is a means of emphasizing the commonality of needs by forcing hostile groups to meet and talk together. Insistence on near-unanimity minimizes the possibility of dominance by any single faction. Furthermore, as a stable body backed by the local economic power of the central village fund, the council is able to approach regional or national lending institutions for capital.

The task of the *gram-dan* workers becomes easier as the effects of central village funds become known within an area. The village of Kutka, for example, has 1,200 rupees (about $180) in their fund; so far they have used the money only for federal and state land taxes. There has been much earnest discussion, however, widely commented on throughout the area, about buying a tractor. About one-quarter of the villagers in Bhoodapuri were in debt when that village pledged itself to *gram-dan;* now only two families remain in debt, and the *gram sabha* hopes to repay their loans within the next year. Another village invested about 600 rupees ($90) on irrigation wells and on a new bull to improve their stock.

Other communities, like Talasari, have used the money to develop a local handicraft industry. Six looms to spin *khadi*, the handspun cotton cloth that was Gandhi's symbol, were built with fund monies. Such local industry provides both employment and a cash product from a low capital investment. Although *khadi* manufacture is considered "archaic" by more sophisticated planners, about 60 percent of all *gram-dan* villages produce such cloth. A farmer with only a small plot of land may earn the extra cash he needs to support his family by sitting behind the large wooden looms of the community and

A miniature variety of banana is grown in many areas of Bihar. Here, the women of a gram-dan *village carry away the vegetative debris from a banana field previously thinned out by the men.*

weaving the popular material when there is no demand for agricultural labor from large landowners.

The *gram sabha* is also a tool for social development. In many ways the assembly, like the Sunday evening gatherings in the community of Kiriah, resembles a New England town meeting. Everyone is allowed to speak. While this slows the decision-making process, it forces different caste and religious groups to discuss their differences. Parliamentarianism is new to Kiriah, and the meeting begins with agonizingly slow politeness. The elected chairman of the council sits uncomfortably in the middle of the group, balancing the books of the village fund on his knees. A family of four who left Kiriah six years ago, before it became a *gram-dan* village, has returned to the community, and the village must decide how to provide for them. The father of the family wants some of his old land back. His only source of income now is from foraging for sticks, which he wraps into long bundles and carries on his shoulders to sell door to door for firewood.

One bare-chested man argues forcibly that the village has no responsibility—the family left during a drought and must take the consequences. They should not come back now, when times are good. An opponent, his legs still caked with mud from the fields, argues just as loudly that the family is still a member of the community. No one seems to pay much attention to him, though; the head of the returning family is his brother. The argument cascades as each man airs his point of view.

One old man, sitting peacefully in the corner, breaks the crescendo of debate. "If your son left," he asks the bare-chested man, "would you not welcome him back? Vinoba has said that the village must be like a family. We must welcome these four and provide them with land." Two hours later a course is decided: money will be used from the village fund to buy a small plot for the new family. It was the name of Vinoba that quelled the debate.

The close connection between *gram-dan* and Vinoba Bhave is one of the movement's prime assets. When difficulties arise, villagers turn naturally to the teachings of the man they consider to be a living saint. Paradoxically, this identification between the movement and the saint is also *gram-dan*'s greatest weakness. Educated Indians, judging the surface rather than the substance of Vinoba's message, decry *gram-dan* as outmoded. While they revere Vinoba, they see little connection between the teachings of an aging holy man and the needs of modern India.

Furthermore, *gram-dan* is not spectacular. Huge dams are more impressive than a new well for the people of Thatheri, and the 1,200 rupees in Kutka's village fund wouldn't keep government planners in paper clips. The concept behind *gram-dan* has been consistently ignored by government planners and remains virtually unknown outside of the subcontinent. This ignorance would be less surprising if it were a splinter movement, but more than 150,000 villages have pledged themselves to the ideal of an integrated and self-sufficient village.

In August, Nazrichawk became a *gram-dan* village. It had become clear that neither government planners nor political parties could solve the community's problems, so the villagers asked the local *gram-dan* worker for help. Late one evening, four men sat in earnest debate on the concrete irrigation ditch that runs through the fields of Nazrichawk. Three of them were leaders of the different caste groups in the village; the fourth, a *gram-dan* worker. In June the community had been split into hostile factions led by these three men; now a dialogue was beginning. Although planting time had passed and it was too late to avoid widespread famine, the village council agreed to take a loan and to repair the pump before the next planting season.

No one can foresee the future of *gram-dan.* It requires sacrifices from some of those who accept it, and it can be difficult to get an agrarian people to relinquish the concept of private property. Only when the situation becomes desperate, as in a drought year like 1972, do large numbers of villages turn to the idea of pooling their resources for the benefit of all.

It is even possible that *gram-dan* will die with Vinoba. It is the image of the saint that attracts *gram-dan* workers, and it is his message that village people find so compelling. After the death of Vinoba perhaps it will be possible to evaluate the impact of *gram-dan* on rural development generally. But in such villages as Nazrichawk, *gram-dan* is now offering seventy-three people a chance to develop through their own inherent strength. ■

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Nearly a third of the world's population depends on the North Atlantic cod as an important food resource—future generations may have to look elsewhere

by Albert C. Jensen

"Be content, the sea hath fish enough." Thus did the British man of letters Dr. Thomas Fuller sum up the prevailing attitude about marine resources in 1732. He reasoned that if the herring fishery failed, fishermen could fish for cod. And if the cod should leave, they could sail a few leagues farther to find them in abundance. Even in the mid-nineteenth century, Dr. Thomas Huxley, the British biologist, wrote, "I believe that the cod fishery . . . and probably all the great sea fisheries are inexhaustible: that is to say, that nothing we do seriously affects the number of fish."

Today, the evidence that all is not well with the cod is presented in statistics issued by the National Marine Fisheries Service (NMFS) of the U. S. Department of Commerce. Their report states that in 1880, a record 294 million pounds of cod were landed by New England fishermen, who still catch the bulk of the cod in the United States. Today, NMFS reports that the catch has declined to 39 million pounds. Because of this, the United States delegation to the 1972 International Commission for the Northwest Atlantic Fisheries (ICNAF) annual meetings in Washington requested consideration of "catch quotas or . . . other supplementary regulatory measures such as closed seasons and/or areas that can effectively be applied to cod stocks so as to avoid depletion of the resource."

This scene of ice-packed North Atlantic cod at New York City's Fulton Fish Market may someday be just a memory.

The resource is a valuable and much-needed one. Many people in the world, from Iceland to Africa, depend on cod as an important part of their diet. To satisfy this demand, fishermen in the North Atlantic annually land more than 7 billion pounds of Atlantic cod. There are several reasons why cod became important as a food fish and thus the object of intensive fisheries: a mild-flavored fish of relatively large size, cod were abundant on many coastal banks in the North Atlantic and could be stored as salt fish or frozen.

Cod range on both sides of the Atlantic Ocean, from the northern Barents Sea south to the Bay of Biscay, as well as around Iceland and the southern half of Greenland. Along the North American coast, cod are found from the southern tip of Baffin Island to North Carolina, but they are most abundant in the Gulf of St. Lawrence, off Newfoundland. In the spring, a trawler may take as much as 35 tons of cod in a two-hour tow. The Georges Bank cod fishery off Massachusetts is less productive: Boston vessels catch cod at an average rate of 1.5 tons a day. Although they are considered groundfish, cod occasionally rise off the bottom, presumably in search of food. They have been caught in waters of all depths, from as shallow as one fathom to as deep as 250 fathoms.

Cod often grow to large sizes. A cod caught on a line trawl off the coast of northern Massachusetts in 1895 weighed 211.5 pounds and was more than 6 feet long. In the commercial fishery today, many thousands of cod 30 to 40 inches long and weighing 10 to 25 pounds are caught each year.

The peak of the spawning season is in December. The female is a prolific egg producer and may shed 3 to 9 million eggs, but only a few of these become adult fish. The adults feed mostly on shell animals (clams, mussels, crabs), squid, and small fish.

Long before Fuller and Huxley made their sweeping—and erroneous—pronouncements, some thought had already been given to the matter of conservation of sea fishes. In sixteenth-century England, fishermen complained about mesh sizes in the crude trawl nets used by other fishermen in the Thames estuary. The trawls, they argued, were capturing and killing many small, unmarketable fish (a complaint repeated in fisheries even now). So it was that in 1558 Queen Elizabeth I published a royal decree setting a minimum limit of two and a half inches on the size of the mesh in trawl nets.

Trawl nets have always been

A trawl net is lowered over the stern ramp of the Albatross IV, *right. The crew sorts out the catch, lower right, after a successful trawl. A scientist, below, first checks for tags, then weighs and measures the cod to estimate their age.*

viewed as a mixed blessing. While they are extremely efficient at catching large quantities of fish rapidly, they catch fish of all sizes and the fishermen throw the small, unmarketable ones back into the sea. Since most of these discarded fish are either dead or dying by the time they are returned to the water, they are wasted for man's use.

The waste at sea, the specter of overfishing, and the fear of what it would do to the resources were the concern of a few far-thinking men a century ago. In 1860 the Norwegians began to keep careful records of the catches of cod landed at their northern fishing villages in the Lofoten Islands. By keeping track of the catches and of the number of fishing boats needed to make them, they obtained an index of abundance—catch per vessel—that is still used in scientific fishery management. Up to then, there had been no way of knowing if changes in the landings of cod actually reflected real changes in the number of cod in the sea.

In the 1930s, Norwegian research on the cod provided additional background information on the life history of the species. Starting with studies of cod eggs and environmental influences on them, the Norwegians moved on to studies of the artificial propagation of cod. This approach was based on the idea that if nature failed to provide adequate spawning, man could intercede to supplement natural production with young fish from hatcheries. Although hatcheries have been successful with freshwater fishes, especially black bass and trout, they have failed dismally with most marine fishes. It is not surprising, then, that the Norwegians discarded the idea of hatcheries and turned to research on the age and growth of the cod in Norwegian waters. Age and growth data provide the foundation for fishery conservation regulations by helping fishery managers determine the optimum age at which fishermen can begin harvesting a species; such regulations insure that the fish are allowed to mature and spawn at least once. These data also help the gear specialists to design the mesh size or hook size that will "select" the mature fish. And, together with data from tagging experiments, physical characteristics of the same species from different fishing grounds, blood-type studies, and surveys of fish populations, age and growth data help determine the need for separate conservation regulations for different geographic areas.

At about the same time that the Norwegians were first taking a serious look at the state of their fisheries, the British began to investigate their own fishing industry. In about 1885 a royal commission on trawling started collecting statistics on catches and number of boats. These data were analyzed and published in 1900 in a report entitled "The Impoverishment of the Sea . . . Alleged Depletion of the Trawling Grounds." The commission had looked at the conditions of the British fishing industry during a ten-year period when the steam trawler boom was at its height. It found that the total catch of all the vessels had increased by nearly one-third from 1889 to 1898. But during the same period the number of vessels had increased by two and a half times, while the actual catch per vessel had declined to about a half. In addition, the average size of the fish in the catch had decreased. If the trend were allowed to continue, the fleets would soon be harvesting many of the young fish before they had an opportunity to spawn. This would ultimately result in a real impoverishment of the sea.

The ideas, speculations, and research of the Norwegians and the British fell largely on deaf ears. It took the cataclysm of World War I to demonstrate that the conservationists were right and that Huxley and Fuller were wrong.

Prior to World War I the scientists who advocated protection of fishes in the sea were speaking largely on the basis of theory and conjecture. They could present no proof that the fish stocks were in a state of decline as a result of fishing efforts, at least no proof that the average fisherman would accept. Thus, in the opinion of the industry, there was no need to regulate the fishing effort to conserve the fish stocks. However, during the period 1913–18, severe restrictions on fishing—the result of wartime shortages of fishermen, gear, and supplies—plus the menace of submarines prowling on the fishing grounds provided the proof the scientists needed: in 1919 the average daily catch per vessel from the North Sea was 3,060 pounds, compared with 1,430 pounds in 1913. It was clear that the fishing hiatus during the war had allowed the fish to grow bigger and heavier. It was not that there were twice as many fish as before, but rather that the fish on the grounds had been able to grow and increase in weight.

In the United States few people seemed worried about the continued supply of cod off the northeast coast of the American continent. Perhaps it was too difficult to even imagine that the great populations on Georges Bank or on the Newfoundland Grand Bank could be affected by man's efforts. But as early as the latter part of the nineteenth century, there were discouraging changes in the abundance of cod, and a few perceptive observers suggested that something was wrong.

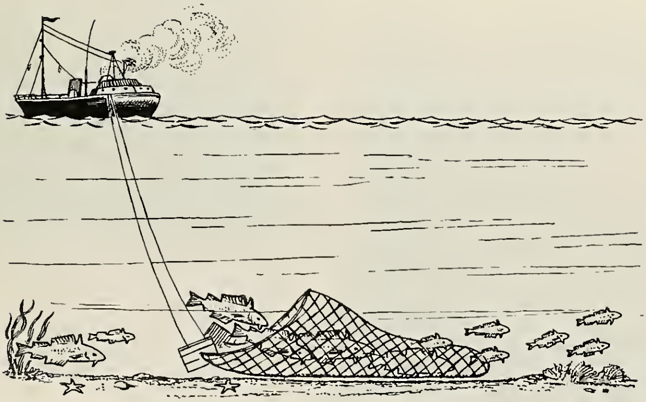
In 1871, President Ulysses S. Grant signed into law a resolution "for the protection and preservation of the food fishes of the coasts of the United States." He also appointed Spencer F. Baird as commissioner of the newly created U. S. Fish Commission and set up a laboratory in Woods Hole, Massachusetts.

Baird made a study of the situation and presented his findings in a report, "Conclusions as to Decrease of Cod Fisheries on the New England Coast." The Fish Commission soon embarked on an ambitious program to increase the number of cod in the sea by building hatcheries at Boothbay Harbor, Maine, and at Gloucester and Woods Hole in Massachusetts.

John J. Brice, a later commissioner of Fish and Fisheries, re-

The stern trawler, Albatross IV, *is a United States fishery research vessel operating out of Woods Hole, Massachusetts.*

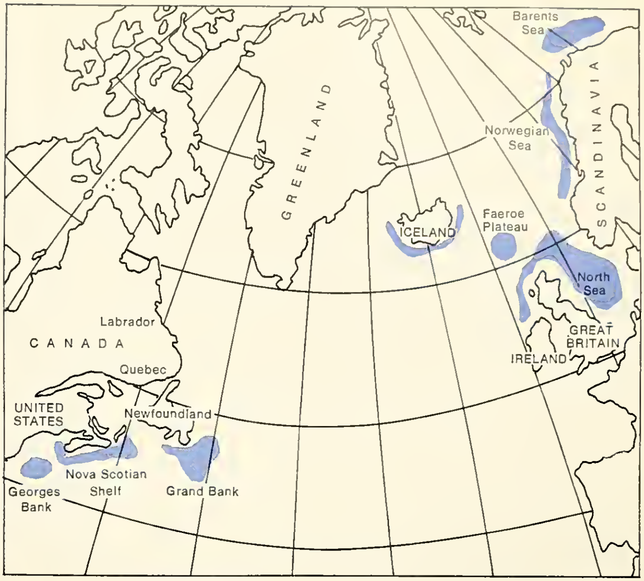
Large-mesh nets allow small fish to escape and grow until they reach marketable size in years to come.



ported in 1898 that the "cod is propagated artificially on a more extensive scale than any other marine fish." Up to the season of 1896–97, a total of nearly 450 million cod fry had been liberated from the hatcheries. During the 1896–97 season 98 million fry were liberated. Brice proclaimed the hatchery operations a success, saying, "The unmistakable economic results which have attended these efforts warrant all the time and money devoted to them and justify the greatest possible expansion of the work."

To insure a steady supply of eggs and sperm, healthy, lively cod—from 1,600 to as many as 9,000 each season—were caught in fish traps or by vessels fishing in the inshore waters and taken to the Woods Hole hatchery to serve as brood fish. There, they were kept in floating live cars in a large outdoor pool. The fish were removed periodically and examined to determine their stage of ripeness. When they were ripe, the eggs and sperm were stripped from the fish into containers filled with seawater and the contents stirred to obtain maximum fertilization. The fertilized eggs were then transferred to hatching trays for subsequent development. Newly hatched fry were taken from the trays and released in nearby waters: the harbor at Gloucester and Eel Pond at Woods Hole. It was at this stage that the entire hatchery scheme failed in its intended purpose.

Because cod are difficult to rear to a large size—supplying food of the right size and kind is perhaps



Hatched areas show the major North Atlantic cod-fishing grounds from Georges Bank, off Cape Cod, to the Barents Sea.

the biggest obstacle—the fry were released at a very early stage of development. Under natural conditions, however, the death rate among young fish is astronomical, and most die in the early stages, perhaps in the first three months. Thus, the hatchery fish were being released when they would be subject to the greatest mortality. Despite the great faith that Brice and others had in the work of the hatcheries, the millions of fish that were stocked really added little, if at all, to the populations in the sea.

The hatchery at Woods Hole continued to function until the buildings were taken over by the U. S. Navy in World War II. Hatchery operations had ended somewhat earlier at Gloucester and Boothbay Harbor, and today there are no cod hatcheries in the United States.

Nor can declining stocks be replenished by migrating fish. The results of many tagging experiments in European and North American waters show that there is no interchange between the cod of the northeast Atlantic and those of the northwest. There are several separate ecological groups of fish. Grand Bank fish, for example, are separate from Nova Scotian fish; Georges Bank fish are separate from the southern New England fish, and so on. Similarly separate groups exist in European waters.

With a host of nations fishing for the cod throughout its range—seventeen countries in the eastern Atlantic and fifteen in the western—multilateral arrangements were made to examine the cod resource with an eye to managing it. International commissions have been established in many parts of the world for the management and conservation of a variety of aquatic resources. Most of them have had mediocre success, particularly with regard to fisheries, and have served primarily as forums for discussion and debate. This is certainly true of the Atlantic commissions. Their principal success has been in conducting research and gathering data for the scientific advisors to present to the commissioners. But in too many cases the commissioners, because of their nationalistic and political leanings, choose to ignore the recommendations of their advisors. The International Commission for the Northwest Atlantic Fisheries, (ICNAF), which held its first meeting in 1951, was established for the "investigation, protection and conservation of the fisheries of the Northwest Atlantic Ocean, in order to make possible the maintenance of a maximum sustained catch from those fisheries." The area covered by the convention includes the entire northwest Atlantic from the west coast of Greenland, and the offing of Labrador, Newfoundland, and Nova Scotia, to New England as far south as Rhode Island. Twelve nations, including the United States and Canada, signed the convention. Most of them were concerned with the rich cod fisheries on the Grand Banks, in the Gulf of St. Lawrence, and on the Scotian Shelf.

Along with its northeast Atlantic counterparts, ICNAF was early concerned with savings-gear experiments to reduce the destruction of young fish in otter trawls. They also examined the possible destruction of small fish caught by gill nets, traps, and hooks, but found that none of these was as destructive as the otter trawl. Their experiments uncovered differences between species in their capacity to escape through the trawl meshes. For example, more cod of all sizes escape than haddock, an indication that regulating mesh size as a conservation measure is not nearly as simple as many biologists would like to believe. Nevertheless, in 1953 the United States passed legislation that established four and a half inches as the minimum mesh size for the cod and haddock fishery on the New England banks, replacing the former two and a quarter inches. The rest of ICNAF followed suit, and today minimum mesh sizes are five and one-eighth inches for west Greenland waters and four and a half inches in the remainder of the convention area.

Recently, however, some experts in the dynamics of fish populations have contended that mesh regulation for such species as cod and haddock is just as ineffective as artificial propagation, and for much the same reasons: natural phenomena, as well as man's other fishing activities, are too powerful as depleting factors. At the 1972 ICNAF meeting, the United States delegation reported, "The scientists have emphasized that the existing mesh regulations are not sufficient in themselves to prevent depletion of these [cod] resources. . . ."

Because of the great number of vessels involved, overfishing has reduced the cod population on many grounds. Further, as the abundance of other species has declined, fishing for cod has increased to satisfy consumer demand, as is happening today in the New England fishery.

We need only look to other grounds to see how precarious local cod populations are and how easily they can be affected by seemingly minor changes in their environment. Forty years ago there were no cod present off Greenland; but a rise of only 1.5 degrees (Celsius) in the average annual sea temperature has made these waters habitable for cod populations. In Norwegian waters, poor spawning in 1965 and 1966 resulted in poor fishing for small cod in 1969 and 1970, and Norwegian scientists predict poor fishing for large cod in 1973 and 1974. In the Barents Sea, low abundance of capelin, a smeltlike fish that is a favorite cod food, resulted in low abundance and small catches of cod. In Danish waters, large numbers of dead cod were seen among other dead and dying fish, birds, and marine invertebrates following an outbreak in October, 1968, of a red tide. Natural disasters such as these easily diminish the effect of mesh regulations and other conservation measures.

There is little we can do about natural mortality, and mesh regulation alone is like patching up one hole in a sieve. What is needed is a comprehensive conservation program. An approach to the solution of the overfishing problem, at least for the Barents Sea, was voiced by Hallstein Rasmussen, deputy director of the Norwegian Fisheries Directorate, at a meeting of the Northeast Atlantic Fisheries Convention (NEAFC) in 1969:

> Rapidly diminishing resources of fish, particularly cod and related species, is one big problem for which a solution has yet to be found. . . . Conservation and replenishment of Northeast Atlantic fish resources depend on much more comprehensive measures than those considered up till now. . . . Nations fishing in the Barents Sea should reduce their total catch from its current level of 400,000 metric tons annually to 250,000 tons. . . . The best solution is to put a complete ban on trawling, at least in areas which are known as feeding grounds for fish before they reach maturity.

It is becoming increasingly evident that stern measures such as these will have to be taken to conserve the stocks of cod. The report of the NEAFC annual meeting in 1968 noted that "control of mesh sizes and minimum fish size had not been sufficient to obtain maximum sustainable yield, and therefore it seemed that effort control was necessary." The question of which nations shall fish—with how many vessels, and for how long a time—is still being debated.

The author, here beginning a dive, almost lost his life riding the working nets of the trawler as he tried to see how young fish escaped.

There is a danger, however, that we may study and debate the problem of overfishing the cod to the near extinction of the species. We have seen this happen with the Georges Bank haddock, which has been intensively studied for nearly forty years. Today it is in dangerously low abundance and tightly controlled catch quotas for haddock are enforced on the fishing grounds. Once the quota has been reached, the grounds are closed for the year to further fishing for the species. The closure of the New England grounds for 1972 was announced effective October 27. With the haddock fishery denied to them, however, New England fishermen will fish more intensively for the cod, and under existing conditions, overfishing and depletion of the cod resource is almost a certainty.

We can no longer be complacent about our diminishing marine resources. What is needed now is a total management plan, not merely such stopgap measures as mesh regulations and catch quotas. The fishery scientists have shown the way. Now it is up to commissioners, administrators, politicians, and diplomats to forego their nationalistic prejudices and implement the management proposals that have been presented to them. ■

Johnson

Return of the Fisher

A taste for porcupine is helping a sleek and elegant predator stage a comeback

by Robert B. Brander and David J. Books

One of the most proficient North American predators is a fast, sleek, and obscure member of the mustelid family, the fisher. A close relative of the marten, wolverine, weasel, and mink, the fisher, a native of the northern forest, is known to few other than trappers, woodsmen, naturalists, and wildlife biologists. Its low profile is due primarily to its densely wooded habitat, restricted range, and low population densities.

Of all its common names—pekan, wejack, black cat, and Pennant's marten—the name *fisher* is least suitable, since the fisher does not fish. The name may have stemmed from its habit of robbing traps baited with fish, or perhaps from its being confused with the otter, an expert fish catcher. Just as likely, however, is the possibility that the term originated with early immigrants who noted the fisher's similarity to the European polecat, a large, dark-colored weasel. Trevor Poole, a Welsh zoologist, notes that other names for the polecat include fitchet, fitche, or fitchew.

The fisher is larger than its nearest North American relative, the pine marten, but considerably smaller than the wolverine. An adult male normally weighs 8 to 12 pounds and measures 36 to 48 inches in length, including its long tail. The female weighs only about half as much and measures 30 to 36 inches in length.

Dark brown to nearly black in color, fishers have slender, muscular bodies, short legs, black feet, and bushy, black-tipped tails. Because their long guard hairs have a white band near the tip, they often appear to be "frosted," or grizzled. Sometimes, a small white patch is discernible on the throat or chest. Their low, rounded ears, piercing black eyes, and pointed nose give them an elfin look. But playful they are not, as their curved, needle-sharp claws, powerful jaws, and businesslike teeth attest. Adult fishers have no known natural enemies, but they can be fierce adversaries when forced to defend themselves, as for example, against hunter's dogs. The fisher's anal sacs emit a foul-smelling musk that can also be used to discourage would-be attackers.

When the white man began his advance across the continent, however, the fisher's defenses were of no use against this new threat. The heart of its original range was coincident with the northern coniferous forest from coast to coast, and as far south as the coniferous zones of the southern Great Lakes states and the mountains of Virginia and Tennessee. Because they are apparently dependent on the presence of a forest canopy, fishers retreated rapidly northward before the ax and plow. By the turn of the century, fisher populations in the remaining forests had declined drastically, mainly as a result of overharvesting by the fur industry. The fisher, because of its inquisitive nature and strong response to strange scents, is a fairly easy animal to trap, and it was ruthlessly exploited because of the high value placed on its dense, lustrous fur.

The demands of the fur trade reached frenzied proportions between 1919 and 1924. At fur auctions in 1920, the peak year, fisher pelts averaged $85 in Canada, and prime pelts brought as much as $300. To trappers, loggers, and homesteaders eking out a meager living in the woods, a single fisher pelt could have meant more than a month's wages. Most fishers were taken by trap, but they were also hunted. On spotting a fisher track in the snow, a woodsman would pack some food, strap on snowshoes, and pursue the fisher—perhaps for days—until it was cornered and killed.

By the 1930s the fisher had all but disappeared in the United States, except for small populations in Maine, the White and Adirondack mountains, northeastern Minnesota, and California. Fur-trade records from Wisconsin reveal how quickly the decline occurred. In the trapping season of 1917–18, 559 fishers were taken in Wisconsin; in 1920–21, the last legal season in that state, only three were taken. California likewise saw the legal take of fishers decline precipitously from 102 in 1920 to two in 1931. By 1940 the once-abundant fisher was extinct in the province of Nova Scotia and dwindling in other Canadian provinces.

Fortunately, several factors intervened to save the fisher from extinction. First, the warnings of some wildlife biologists and other concerned parties resulted in closed trapping seasons in many states. Wisconsin was among the first, closing the fisher season in 1922, Minnesota followed suit in 1929, New Hampshire in 1935, New York and Wyoming in 1936, Maine and Oregon in 1937, and California in 1946. While seasons were seldom closed in Canada, laws requiring registration of trap lines succeeded in reducing the fisher harvest. Second, women's fashions, which had created the high demand for fisher in the first place, turned away from long furs to the spotted cats. By the 1950s, the price of a fisher pelt was down to a low of $10 or $15. And third, much of the fisher's habitat has improved steadily since the 1920s, when our northern forests were at a low ebb from overcutting and subsequent overburning.

In the last 30 years there has been a sharp rise in the fisher populations of areas still possessing breeding stock. New York noted a fisher increase by 1940, Maine by the mid-1940s, and New Hampshire by the early 1950s. Limited trapping seasons were reopened in these states in 1949, 1950, and 1961, respectively.

Minnesota, the only refuge remaining in the Midwest three decades ago, has also seen its fisher population increase. While the trapping season on fisher has been closed continuously since 1933, Minnesota has encouraged trappers to turn in fishers caught in traps set for other species by paying them half the pelt's auction price. The average accidental take increased from 22 per year between 1934 and 1938 to 114 per year between 1959 and 1963. We believe this reflects a real increase in fisher numbers, not just a fluctuation in fur value.

Protection programs were not sufficient to re-establish the fisher in all parts of its original habitat, however, and reintroduction of breeding stock will be required in many states. Given the still prevalent attitude toward predators in general, any proposal to release such animals is likely to raise a hue and cry from certain influential segments of the public: hunters anticipating a decline in game animals, farmers fearing depredation of livestock and poultry, and those animal lovers who object to the death of any prey species might all be expected to oppose a restocking program involving a predator. One can imagine the reaction that would greet an attempt to reintroduce wolves on their former range. The fisher, however, has a potential degree of public and governmental acceptance not enjoyed by other predators because it is the only animal that effectively preys upon porcupines.

In recent years, the porcupine population has increased in many areas of the United States, with densities reaching as high as 60 animals per square mile. Chewing the cambium and bark of trees during winter and feeding on tender buds, leaves, and twigs during spring, these rodents can kill valuable timber and ornamental trees. They are also pests near camps and summer homes, gnawing at anything that contains salt, such as canoe paddles, ax handles, and saddles that have become salted from human perspiration. These habits have not endeared the porcupine to people whose property has been damaged by the rodent.

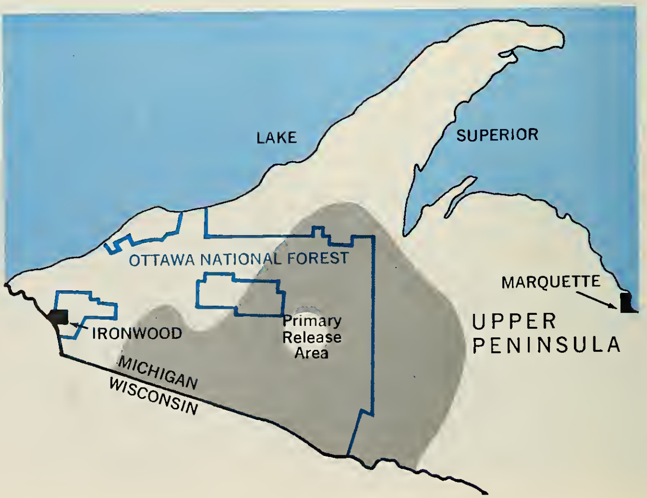
Fishers and porcupines share much of the same habitat—heavily wooded areas of conifers, junipers, and poplars—and it had long been thought that the fisher was the primary natural control on the number of porcupines in an area. Our study of a recent fisher restocking program in northern Michigan substantiates this theory.

As a hunter, the fisher is largely an opportunist. It does not lie in wait like a bobcat or pursue prey for long distances like a timber wolf. Rather, its hunting pattern is a random investigation of brushy areas, windfalls, hollow trees, and other places where hares and smaller mammals are likely to be found. Fishers are renowned for their speed and agility in trees, and many early accounts would have us believe that their hunting activity was primarily arboreal. However, we saw little evidence of tree climbing, and a study in Maine also showed that most of the fisher's activity is terrestrial, although certain individuals do climb trees readily and often.

Throughout much of the fisher's range, the snowshoe hare is the staple of its diet; other foods include squirrels, mice, shrews, birds, carrion, fruits, and nuts. Deer remains commonly turn up in the digestive tracts of fishers. It is highly unlikely, however, that a fisher could kill any but the weakest deer, considering the disparity in size. This has been supported by studies of deer yards in Maine where fishers were present but did not hunt the snowbound and winter-weakened deer. The deer remains found in the stomach con-

Fisher Distribution in Michigan—1970

Number of Fishers Released:
1961—31
1962—16
1963—14



In trees, porcupines are less vulnerable to predation than on the ground, where fishers can more easily attack their heads and faces.

tents of fishers can be explained by their tendency to feed on carrion; they will often remain near the carcass of a deer or other large animal for several days.

Ruffed grouse remains are sometimes found in fisher stomachs, but the fisher does not constitute a threat to grouse populations. The claim by some sportsmen that fishers stalk and kill grouse roosting under the snow is unsubstantiated by our experience with the two species in northern Michigan.

Porcupines are a highly preferred prey, and if fresh sign is in evidence, a fisher will become more deliberate in its hunting habits, often spending several days in the same area. Porcupines, protected by their defensive armament, move through the woods without making any noticeable effort to avoid an encounter with a predator—possibly because they have none except for the fisher. Rare eyewitness accounts indicate that when the two meet, the fisher rushes in, leaping and circling rapidly to confuse its prey. Repeated attacks to the face and head soon kill or cripple the porcupine and enable the fisher to rip open the rodent's soft, unprotected belly. The popular literature has erroneously reported that fishers kill porcupines by first flipping them on their backs, then attacking the belly, or by attacking from underneath when both animals are in a tree. Malcolm Coulter of the University of Maine has studied fisher behavior in the wild and he also reports that fishers kill porcupines by attacks to the face and head. Wounds are inflicted by both the teeth and claws, and feeding begins either at the belly or the head. Little is left of the porcupine when the fisher is finished except for a few pieces of skin and some scattered quills. Even most of the bones are cracked and eaten.

The fisher frequently receives a number of quills during its attack, but these do little harm. Dead fishers examined by biologists often have soft, partially dissolved quills lodged harmlessly under the skin, in the stomach and intestines, and in muscle tissue; rarely is there any sign of inflammation or infection. The reason for this immunity to any ill effects from quill penetration is not known, but it is certainly important in the fisher's success against the porcupine. Other predators have been found suffering from quills in their bodies, and fatalities may occur as the injured animals gradually succumb to infection or to the inability to hunt for other prey. Most predators simply give the porcupine a wide berth.

Since the great decline of the fisher population in the early part of this century, the porcupine population has shown a steady, and in many cases, a dramatic increase. This was particularly true in Ottawa National Forest, in the western half of the Upper Peninsula of Michigan. Porcupine damage to timber trees had reached serious proportions, and despite various control measures, the population densities of the rodent remained a very high 30 to 60 per square mile. Anxious to avert any more economic loss and recognizing that the absence of any natural predators had resulted in a serious imbalance in the forest ecosystem, the United States Forest Service undertook a restocking program. Between 1961 and 1963, the Forest Service live-trapped 61 adult fishers in Minnesota and released them in the forest. We immediately began monitoring the establishment of these fishers as part of a long-term study of porcupine food habits and population dynamics in the area.

A few years after the reintroduction, sightings and sign of fishers were being reported over a large area surrounding the release points. More than 15 percent of these sightings have now been made more than 30 miles from a release point, suggesting a significant expansion of the fisher in ten years.

Over this same period, the number of porcupines in the release areas has declined. We obtained direct evidence for this through censuses of porcupine populations in two fisher release areas during the winter of 1962 and each winter since 1970. By 1970 porcupine numbers in one area decreased from 36 to 9 per square mile during the ten years following the first release of fishers; in the other, porcupine numbers declined from 27 to 21 per square mile. Area residents emphatically state that there are considerably fewer porcupines now than in the 1950s and early 1960s. Foresters who used to shoot porcupines to control destruction of valuable timber now report that they rarely see the lumbering animals. Handguns, which were once standard equipment in woods work, are seldom carried now. The number of porcupines killed by Forest Service personnel in the heart of the established fisher range also illustrates the decline. The kill fell from 360 in 1960 to fewer than 50 in 1969.

We can only speculate on the numbers necessary for porcupine–fisher populations to reach a state of equilibrium. Our observations indicate that while fishers obtain most of their energy from snowshoe hares, they will attack any porcupine they encounter. Chances of finding a vulnerable porcupine are high when the population is high, and are reduced as the population declines. Eventually, the kill-rate will come into balance with the porcupine birthrate. We see some evidence that such a balance is being struck in the populations we are monitoring.

This system could become unbalanced again if the number of porcupine dens secure from fisher intrusion came into short supply, and we have some indications that this is also happening. In 1962, before fishers were established in significant numbers, nearly 50 percent of all porcupine dens were in hollow logs; in 1970, however, only 10 percent were in logs. We think this reflects the relative ease with which a fisher can harass a porcupine out of a log. A secure den is usually in a live, hollow tree. Because of the small entrance hole, a threatened porcupine can climb up into its wooden fortress and readily defend itself. We have observations, based on tracks in the snow, of fishers approaching porcupine den trees and sitting for long periods in front of the entrance, but not entering. Den trees may be occupied by a succession of porcupines for many years, as evidenced by the large accumulations of droppings at their entrances. Some of the den trees that we have had under observation have been occupied continuously since, and even prior to, our first records in 1961, further suggesting the security they offer the occupant.

Den trees in our study area are of four species: yellow birch, elm, sugar maple, and basswood. They become potential dens only when they reach a mature size, usually more than 20 inches in diameter. But in recent years these species have become highly valuable for timber; consequently, few are being allowed to grow to the required size for dens. If this trend continues, there will eventually be

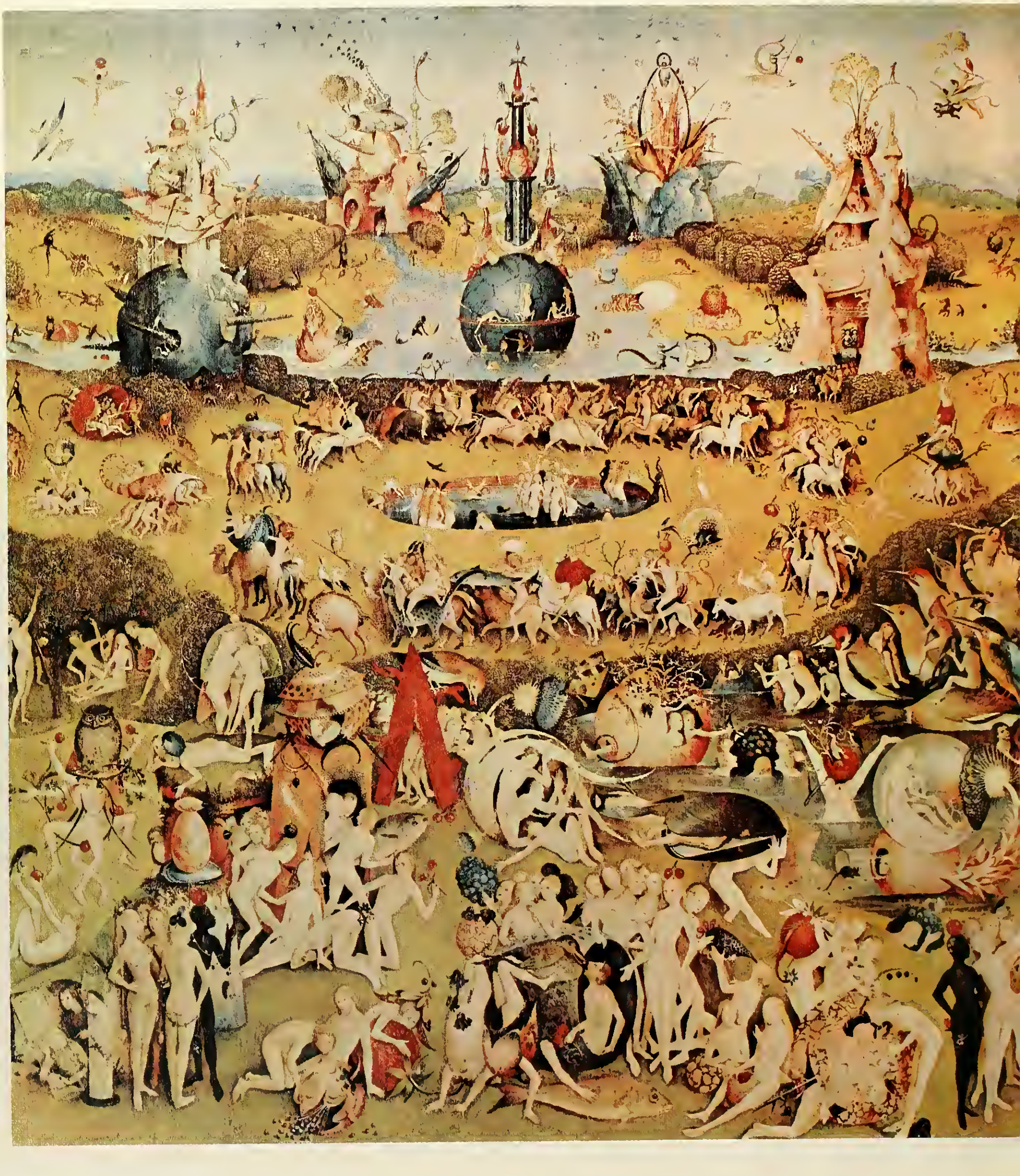
Fishers frequently travel through the trees in search of such prey as squirrels, but most of their hunting is terrestrial.

a shortage of secure dens—perhaps in 50 years when most of the existing large, hollow trees will have died and fallen.

The fisher's economic and ecologic value can be clearly appraised. From an economic viewpoint, the place of the fisher in the North American fur trade has never been exceedingly high—about $215,000 of the $34,000,000 market of 1968-69. In Ontario the fisher currently ranks tenth in importance among fifteen furbearers. However, in places where the total volume of furs trapped is lower, the fisher may assume a greater relative importance. In New Hampshire, for instance, 942 out of 17,951 furs trapped in 1969 were fisher, making it fourth out of ten in terms of number of pelts taken and second in monetary return.

Ecologically, the fisher is valuable because it preys on medium-sized herbivores such as squirrels, snowshoe hares, and porcupines, thus helping to check their potentially rampant fertility. If the fisher's niche were vacated, other carnivores would attempt to fill it. Birds of prey, the cats, the coyote and the fox, and other members of the weasel family could compensate for the loss of the fisher in some respects. Only the fisher, however, preys effectively on the porcupine, thereby cutting down on substantial timber losses in areas where the rodent has multiplied unchecked. The ecological argument, then, also becomes an economic one.

As people begin to better understand the predator-prey relationship between the fisher and porcupine, the fisher's return to its former territory will be welcomed for the benefits it will bring. ■



Medieval Beasties

If you want to unravel medieval legends and myths, be prepared to run, jump, and stand still all at the same time

by Frank J. Anderson

In the center panel of the Garden of Earthly Delights, *Hieronymus Bosch positioned the fierce merknight Zytiron, a symbol of anger and lust, confronting a mermaid in the right foreground of the main pool. A slightly different version of Zytiron, mounted on a fish, appears in the upper right corner of the panel.*

Having persisted through a long, hard night of disbelief, mythology is once again gaining credit in a few respectable circles. Archeology and psychiatry, two of its newfound friends, are now busy removing the tarnish from its reputation. This process began when Heinrich Schliemann rediscovered Troy by placing his confidence in ancient, worn-out tales. The modern Israelis, following the same method, have also uncovered sites thought to be merely legendary. And psychiatry, through the voice of one of its major prophets, Carl Jung, has even suggested a science of mythology.

The natural sciences, too, have supplied a few samples as evidence in favor of the reliability of myth. Most of these have risen out of exaggerated or misinterpreted reports that were based on poor observation. Examples that immediately come to mind are the manatees and dugongs, which wishful sailors transformed into mermaids, and the common oranges that became the golden apples of the Hesperides. Almost all myths are constructed after the same fashion: a hard kernel of fact is overlaid with layers of decoration and padding, much like a slightly larcenous expense account.

One of the great myth-making periods ran from postclassic times to the sixteenth century, but at the time of their creation, few of the legends were regarded as fictitious by either their creators or their perpetuators. Most of these fables were based on hearsay information, which when circulated in manuscript form lent themselves to further misinterpretation. A busy scribe, with little time to check over what he had set down, was often guilty of errors of both sight and hearing; some works were copied by dictating to an entire battery of scribes, and one error could beget another as easily as amoebas can establish a family. As a consequence, medieval manuscripts abound in puzzlements and oddities. Creatures were fathered out of a combination of ignorance and illegibility, assisted by an inexhaustible passion for the miraculous.

Three such garbled progeny seem to be more endowed than others with their creators' passion for the miraculous. The first of the trio is called Zytiron, the Fish-tailed Knight, monstrous terror of the seas. Helmeted in steel and encased in armor, he looked the very figure of the noble knight, complete with shield and gauntlet. But below his waistline a curious change occurred, for his lower half was that of a fish.

For some unaccountable reason, this odd being enjoyed a wave of popular appeal in Flanders and Germany during the final decades of the fifteenth century. He is found gracing the border of a Flemish Book of Hours from the Ghent–Bruges area and is also the subject of a carving on the choir stalls at Saint Sulpice in Diest. Hieronymus Bosch depicts Zytiron confronting a mermaid in the central panel of the fantastic *Garden of Earthly Delights*, and he is described and pictured in the many editions of the famous medieval herbal *Hortus Sanitatis*, or *Garden of Health*. He was, in short, the kind of fellow who got around.

But for all his fame, Zytiron's antecedents are a little hazy, a condition that was not altogether uncommon during the Middle Ages. The firmest birth date that can presently be assigned to him is 1491, the year in which he appeared in the first edition of the

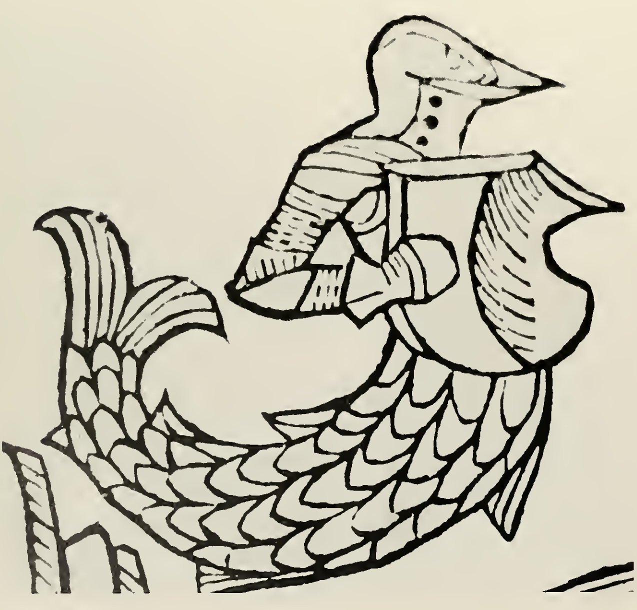
Hortus. The text in that massive Latin work speaks of him as being armored like a knight of old and calls him "great and out of measure strong." He is said to wear a helmet, while pendent from his neck is a shield bound to his body by many sinews. Upon his hand he wears a gauntlet, divided only at the thumb, and with this "he stryketh ryght sore."

Yet when this verbal disguise, woven out of simile and metaphor, is finally penetrated, our armored monster of the sea loses his knighthood and dwindles down to nothing more awesome than that gourmet's delight, the lobster. The shield hanging from his neck and fastened to his body is simply a carapace, while the singly divided gauntlet is just as plainly a claw—with which he can strike very sore indeed.

But matters don't end with mere identification, for the lobster possesses certain characteristics that make it of interest to an iconographer. In the Old Testament the lobster is placed in the category of the unclean, a defiler of all who so much as touch it. Hieronymus Bosch, penetrating Zytiron's disguise in the *Hortus Sanitatis,* seized on his transfigured form as a fresh symbol of sinfulness, one that combined anger and lust. Anger was a way of life with the lobster, which was reflected in the warlike pose of the merknight. Lust could be attributed to almost any creature that was loathsome and unclean, and since this was the verdict of the Scripture itself on the crustacean, its place in iconology was fixed.

The second member of our mythical threesome is a citizen of two worlds, the animal and the vegetable. Variously known as the Tartarian, Scythian, or Vegetable, Lamb, it is also called by the Tartar name of Barometz, and is a considerably more innocent creature than the lobster-knight.

Although its ancestry goes back to ancient Hebrew writings in the Talmud of Jerusalem, the Lamb did not enter European literature until the Middle Ages. Friar Odoric of Pordenone first made mention of it in 1330 while he was describing his travels to the Orient, and some thirty years later Sir John Mandeville recounted much the same tale.

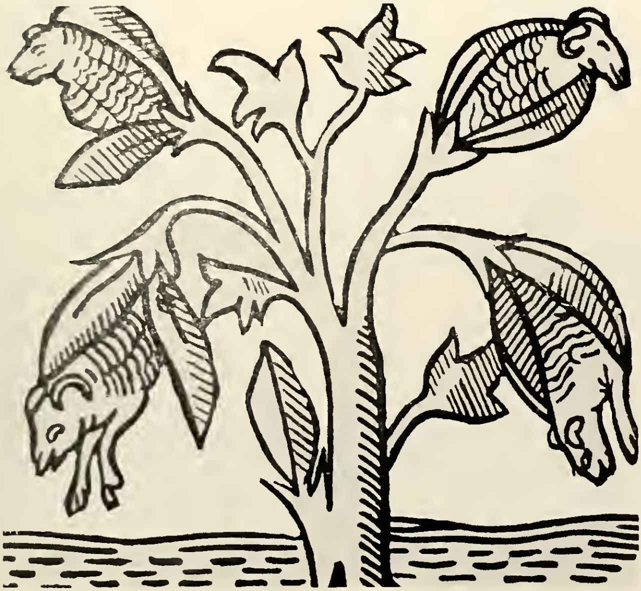


Zytiron, as he appeared in the second edition of the Hortus Sanitatis, *published in Strasbourg by Johann Prüss in 1498. The text described him as being "great and out of measure strong." His gauntlet was divided only at the thumb, and with it he could "stryketh ryght sore." The firmest birth date that can be assigned to Zytiron is 1491.*

This peculiar plant-animal was described as being a full-sized lamb, fixed at its navel to a stalk that rose out of the ground. It fed by bending and stretching to reach the grass that grew around it, and when the supply failed, it died—unless, of course, the wolves got to it sooner. Barometz was, therefore, a perfect model of meekness, living out its life without harm to any other creature. For this reason, many medieval churchmen saw it as a prefiguration of the true Christian, an archetype of the Mystic Lamb, and argued that it was to be found growing in Paradise. It did, in fact, turn up in the very center of Paradise on one occasion, but that was only in the frontispiece to Parkinson's *Paradise in Sole, Paradisus Terrestris.* He also wrote of it in another of his works, the *Theatrum Botanicum* of 1640, but few others believed in it by that time. Still, Erasmus Darwin, writing about a century later, gave it a place in his *Loves of the Plants*, although he changed both its location and color. After Darwin, all is either silence or derision, for the legendary plant-animal was never discovered.

The reason, of course, lies in the misleading description of an Asiatic plant as a "wool-bearing tree," one that bore as its fruit "fleeces surpassing those of sheep in beauty and excellence." These snowy fleeces were nothing but the opened bolls of the cotton plant, for that was the true Tartarian Lamb, a purely vegetable product with no taint of the animal about it. Growing in India, it was woven there and reached markets to the west by way of Tartary. There, it was often sold side by side with the Tartars' own woolen goods and lambskins, thereby setting the stage for myth making. Thus, there arose an understandable, charming, and colorful error that puzzled many Europeans for centuries.

And it was scarcely any the less puzzling to the Tartars themselves. They were constantly being asked the whereabouts of the Barometz, which in their language meant a plain, ordinary four-legged sheep. But these inquiring strangers wanted a different Barometz, one that grew on a stalk or a shrub. And what could be done



The Vegetable Lamb illustrates a chapter in Voiage and Travayle of Sir John Mandeville, Knight, *published in London in 1568. This plant-animal was also described by Parkinson in the* Theatrum Botanicum, *in 1640, and about a century later, Erasmus Darwin mentioned it in his* Loves of the Plants.

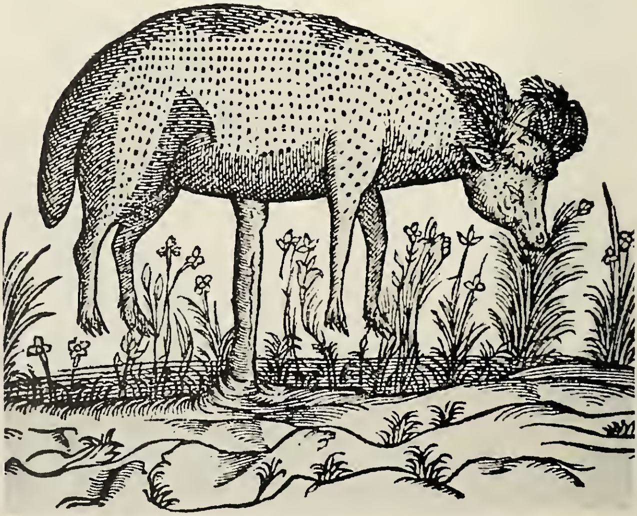
with people who insisted that something of that sort was to be found in the neighborhood when every sensible person knew better? The only logical thing, of course, was to send them on to the source of all good legends—some place farther down the road.

The last of the fabulous creatures on our list enjoyed the most mixed ancestry of all. It began on a tree, passed through a marine stage as a barnacle, and then ended up as a fowl. This magnificently impossible being, known as the barnacle goose, was once a common article of sale in the medieval Lenten markets, for the bird was real even if its pedigree was not.

Giraldus Cambrensis, writing the history of Ireland in 1186, was the first to chronicle this legend, which had circulated for some time among Irish and Scottish fisherfolk. He described the bird's manner of generation in rotted timbers floating on the sea, and related how it hung by its beak within a heart-shaped shell until it was mature enough to fly or swim away. If Giraldus had stopped there, the legend might have remained no more than a local myth, but he went on to state that some of the Irish clergy made "no scruple of eating these birds on fasting days, as not being flesh, because they are not born of flesh." This news delighted ordinary men who found the rigors of Lenten fasting just a bit too demanding, and churchmen suddenly found themselves with a rather thorny problem on their hands.

Concurrent with the quandary that beset the Christian community, rabbis also found themselves faced with an unusual puzzle. If these geese originated as shellfish, they were obviously unclean, but if the shellfish had been engendered from wood, what then? And if that question was answered so as to satisfy dietary laws, an even nastier one lurked beyond. How, exactly, were these geese to be killed so as to render them ritually clean? Nowhere in the dietary laws was there a ruling on the case, and nobody wanted the responsibility of declaring one. In the meantime, the goose graced as many tables among the Jewish brethren as it did among the Christian.

The legend was still alive in the early part of the seventeenth century. John Gerard wrote about these fowl in his *Herball* of 1597, and even showed the veritable goose-tree, together with the geese being born of barnacles. Ulisse Aldrovandi, an Italian naturalist

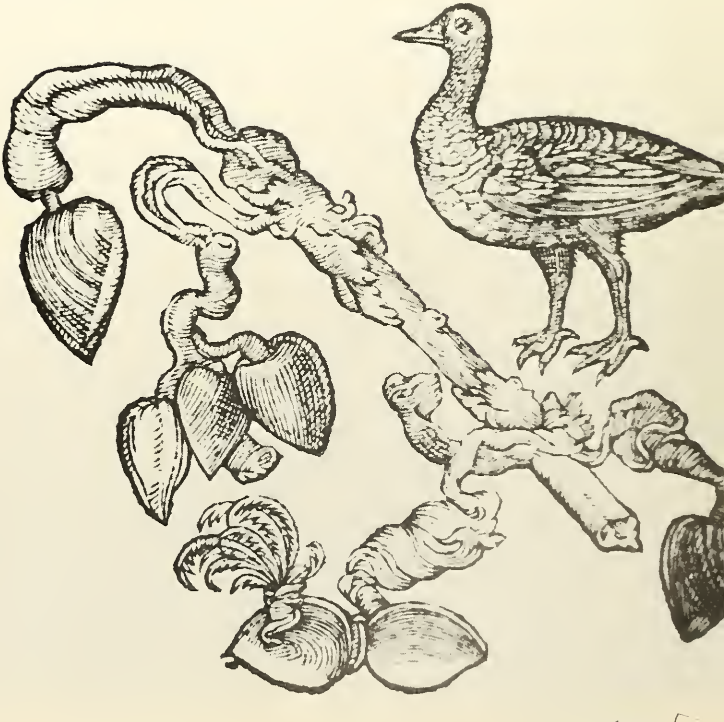


Another version of the Vegetable Lamb, known as Barometz, was described and illustrated by Claude Duret in Histoire admirable des plantes et herbes, *Paris, 1605. The book speaks of Barometz as having "fleeces surpassing those of sheep in beauty and excellence."*

writing at the same time, also took the story seriously. But doubt was growing on every side. Another Italian naturalist, Fabio Colonna, firmly stated that the goose-barnacle did *not* have its origin on land, that geese did not rise from it, and that it was entirely a marine specimen and remained so all its life. He was right in line with Aeneas Silvius, who a century earlier had been skeptical of these birds. Seeking their place of origin while he was on a diplomatic mission to Scotland, Silvius was forever referred to yet another place, and concluded that "miracles will always flee farther and farther away."

Nevertheless, the fishermen did have a certain amount of reason on their side. For one thing, these birds always flew in from the northern seas, and nobody ever saw them breed in any corner of Europe. What were Irish and Scottish observers to think when ignorant of the fact that the barnacle goose, *Branta leucopsis,* actually bred in the Arctic barrens out of the sight of man? They were also aware that a small, white, goose-shaped form could be found inside opened barnacle shells and that a kind of feathery appendage often protruded from the shell's mouth. To them this was clear evidence that, if its feathers were to be found sticking out, the goose was most certainly being formed within. Unaware that this was the means by which the barnacle swept food from the waters, they added two and two together and got infinity as an answer, something not entirely unknown in human history.

So the next time you encounter a description of a seemingly impossible beastie, don't dismiss it altogether. Hidden beneath the camouflage there is very likely to be something real or something odd, but always something to tell us a little more about the workings of the human mind. ■



This illustration of the barnacle goose in Gerard's Herball, *second edition, London, 1633, showed the bird's development through the embryonic stages of its life. First chronicled in Ireland in 1186, the bird's origin was of interest to Jewish communities as well as to the Christian clergy, particularly during the Lenten season.*

Arctic Renaissance

The process of acculturation has given the Eskimo a new medium of expression; and the world a new art

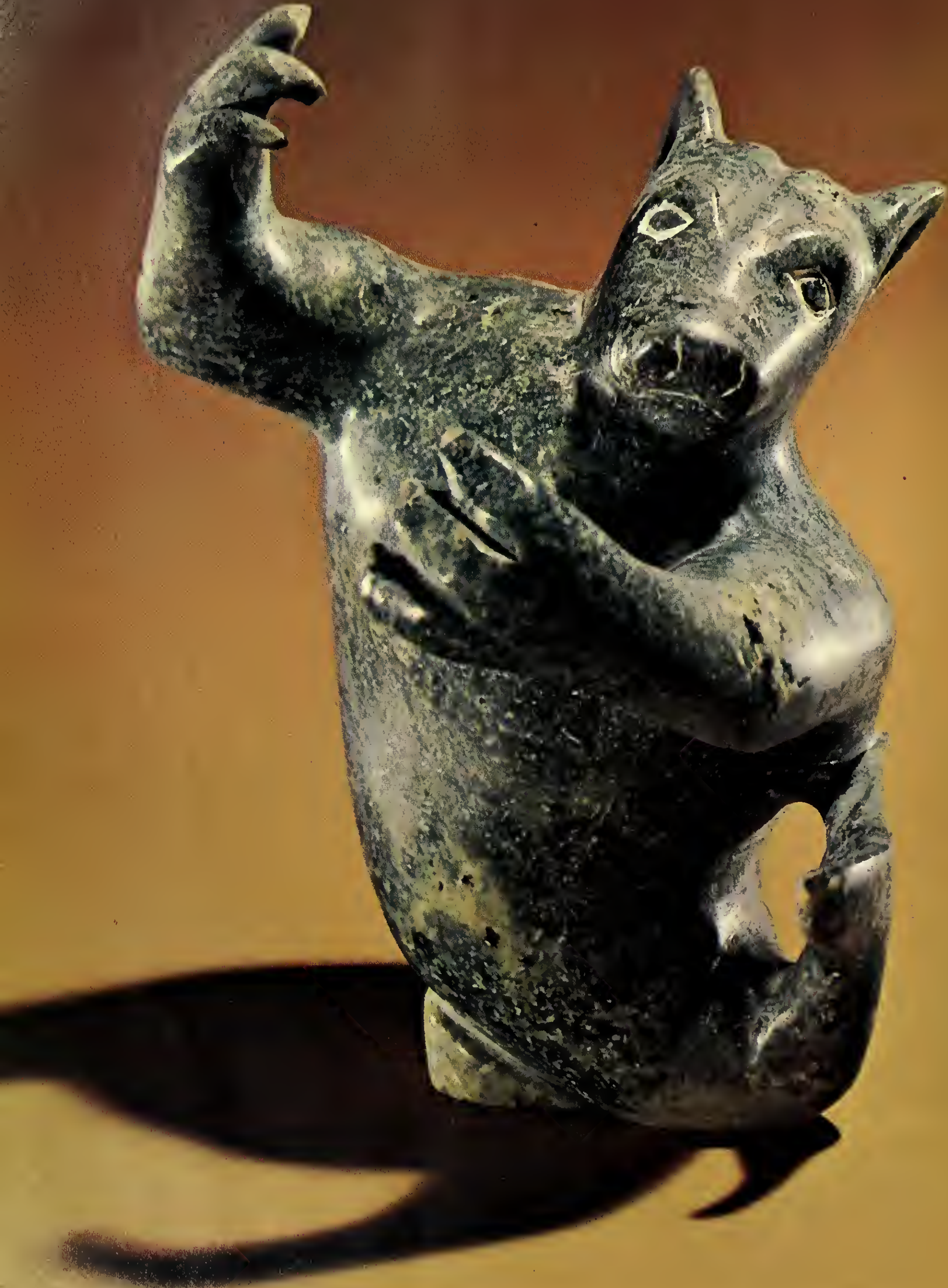
by George Swinton

Contemporary Eskimo art is a new art form of the new Eskimo. Although the Eskimo himself has changed, his art is intrinsically and uniquely Eskimoan. Essentially, contemporary Eskimo art is a product of indigenous and acculturated techniques and the introduction of new materials.

To the purists, all new materials used by "formerly preliterate" cultures are evil aspects of their cultural degradation. To the Eskimo, however, new materials have been a source of stimulation and enrichment. One of the most exciting facets of all Eskimoan cultures is their fertile ingenuity in exploring and exploiting materials and in extending their uses.

The traditional materials for art objects were many: ivory and bone, antler and wood, stone and leather. Stone was perhaps the least used because of its weight and fragility; but however little it was used for art, stone played a major role in utility carving. The entire earlier economy depended on the use of stone cooking pots and stone lamps. Yet it was primarily carving in stone, and stone inlaid with ivory, that caught the initial attention of the non-Eskimo world. Now stone has become so much used that many artists and collectors think of stone carving as the most legitimate form of Eskimo art. Carving in stone certainly is typical of the past twenty years; however, other materials and techniques, such as drawing and printmaking and, to a lesser extent, watercolors and oils, as well as ceramics, are being rapidly absorbed into the Eskimo art ethic and transformed into new expressions.

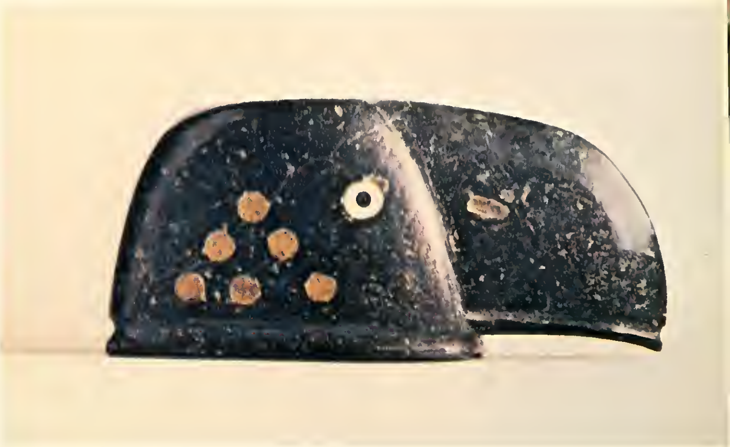
Drawing and printmaking certainly are not Eskimoan art techniques, nor are paints and crayons indigenous materials, yet the drawings and prints of some Es-

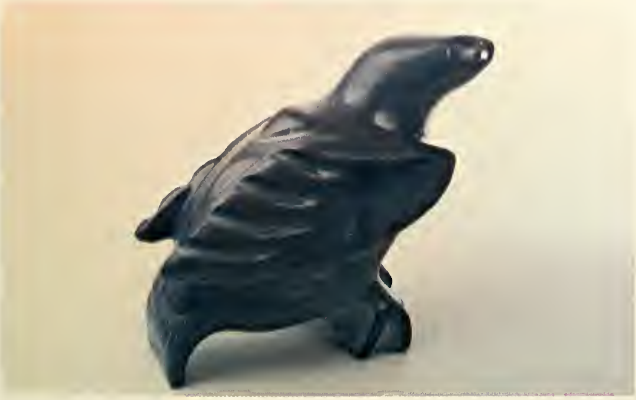


Left
Artist: Kiawak
Cape Dorset
Baffin Island, 1956
Stone; 6 inches high

Right
Artist: Unidentified
Port Harrison, Quebec, 1949
Stone with inlaid materials
5½ inches long

Below
Artist: Emikotialuk
Belcher Islands, Quebec, 1970
Stone; 7¾ inches high





kimo are so thoroughly Eskimoan that the formerly foreign materials and techniques are now part of the new traditions, just as is syllabic writing, which was introduced by an Anglican missionary only some seventy years ago.

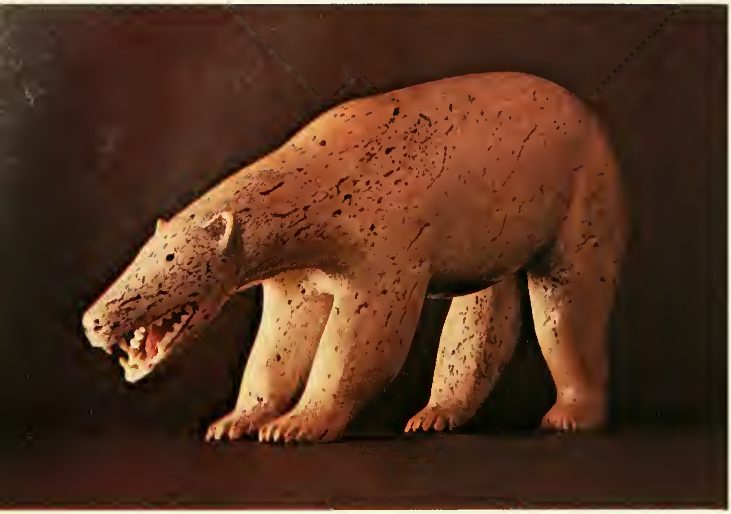
Soapstone carving, or more correctly, carving in stone, is part of the contemporary Eskimo culture even though its forms and its widespread uses as art material and technique are of only recent vintage.

In earlier times, carving efforts seem to have been directed toward achieving more favorable conditions with adverse forces in the universe or, perhaps, toward ensuring that such forces would not operate. In contemporary periods, carving became a predominantly casual activity, producing functional, decorative objects as well as toys and "whittles" made for self-entertainment. In fact, many of the earlier amulet carvings of animals and birds, or characteristic details of them, such as caribou hoofs, bear heads, sea mammal skulls or parts, and bird beaks, were replaced by the actual animal's parts, natural or real objects, rather than carved effigies. And instead of magical objects needed for one's spiritual survival, more objects for secular gratifications came into use.

The secularization of all aspects of life came about because hunting, on which all Eskimo life depended, had lost a great deal of its sacred content. Hunting once was an inseparable part of the spiritual existence in which every Eskimo participated in personal and communal ways. But more than that, because of the hunter's mystical and sacred relationships with the animal world, animals and their soul-spirits and spirit-bodies were integral components of Eskimo life, kinlike and directly affiliated with one's existence. These relationships are evident in almost every aspect of Eskimo mythology and legends. With the coming of the whalers and traders eager to exploit the rich fur resources of the North, the Eskimo began to hunt and trap fur-bearing animals for barter. This commercialization broke the sacred bonds between animal and man and led to the secularization not only of the hunt but of Eskimo life itself.

At the same time, the Eskimo discovered the potential of making likenesses for barter. Contact with whites engendered the secularization of art as well as the hunt.

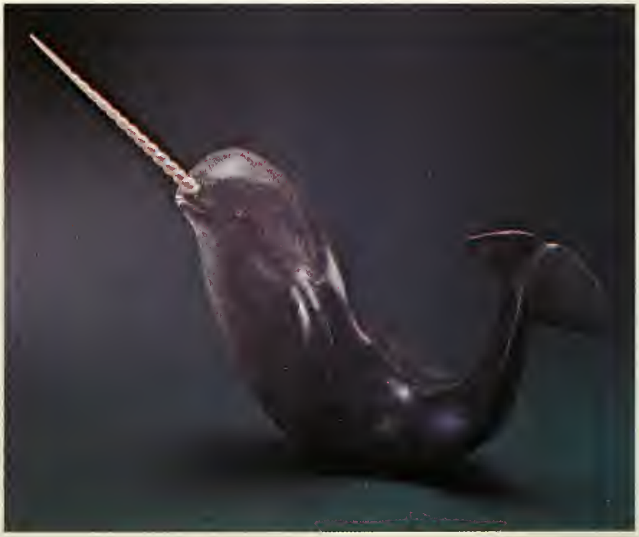
Today's art reflects the changed conditions of Eskimo life; but instead of the mere negative aspects



Left
Artist: Elisapee Kanagna
Arctic Bay
Baffin Island, 1960–61
Whalebone; 3¾ inches high

Right
Artist: Oshooweetook "B"
Cape Dorset,
Baffin Island, 1968
Stone; 19¼ inches high

Below
Stone narwhal
with ivory tusk

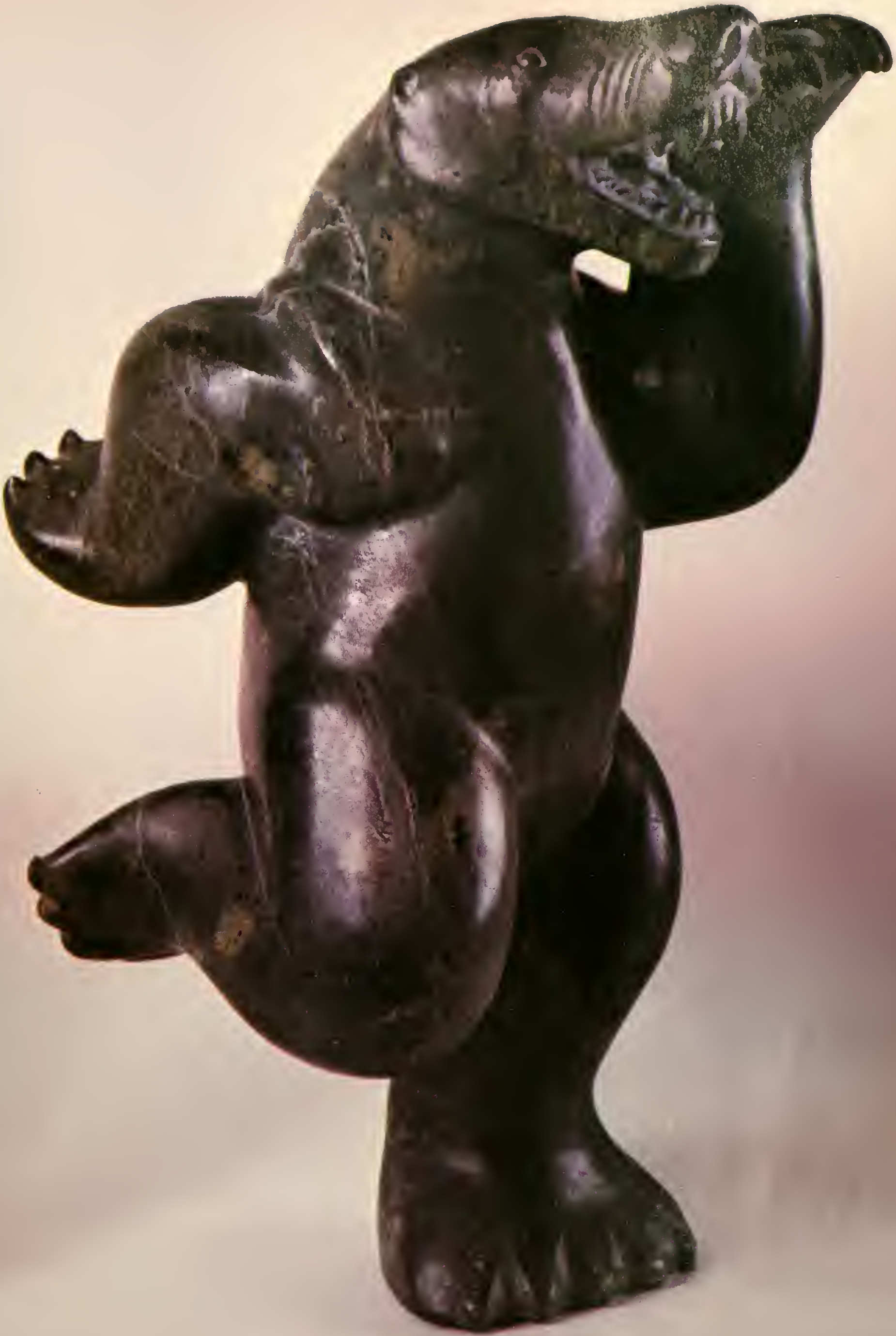


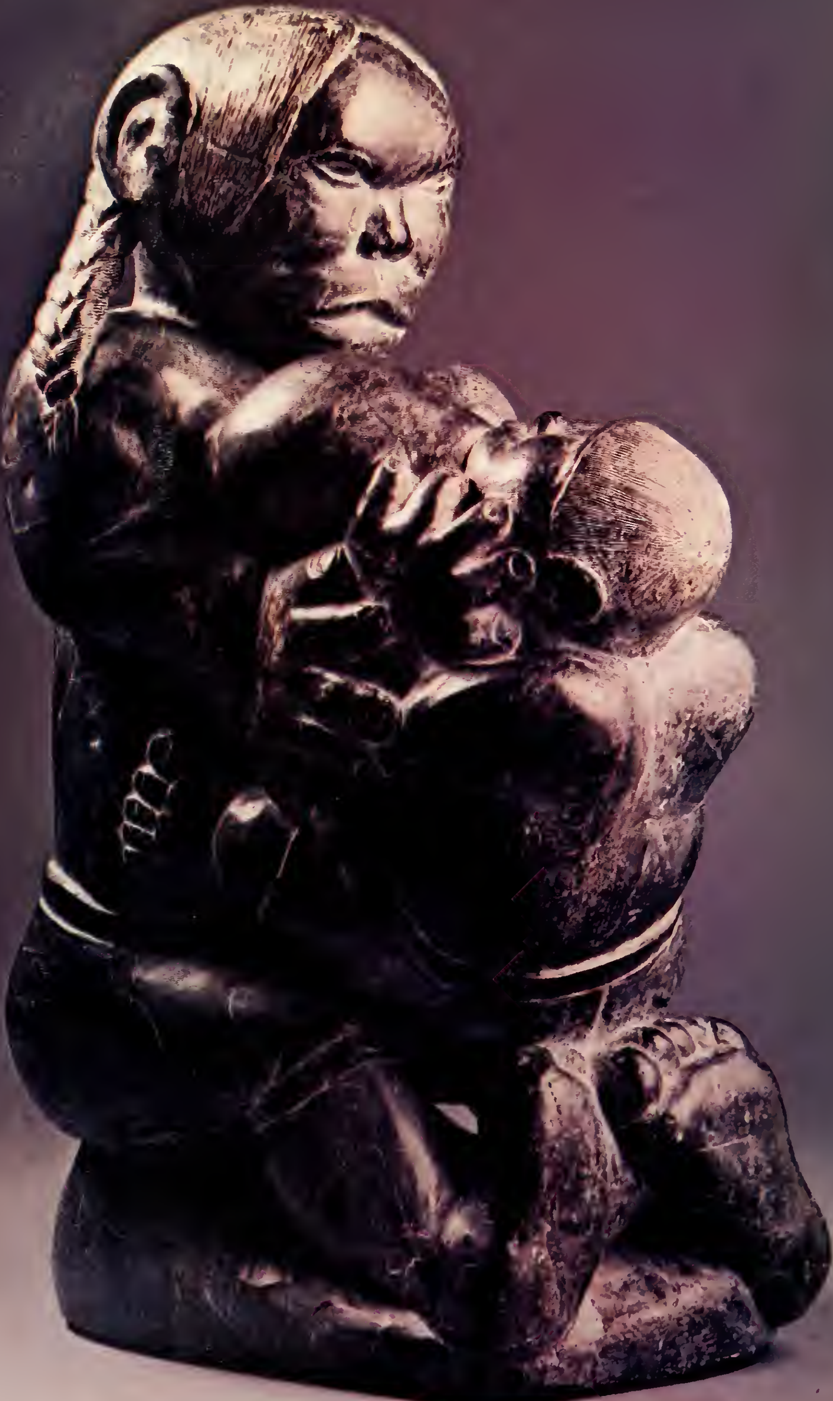
of acculturation, there has emerged a defiant spirit of self-affirmation that is no longer merely immanent, as in the 1950s and early 1960s, but that is also demonstrated in such social action as cooperatives, settlement councils, and participation in governmental and national associations.

Since the emergence of contemporary Eskimo art forms in about 1948, a major criticism leveled against them has been that they are based on Western (Euro-Canadian) and not Eskimo values. The reason for the criticism was that most art that appeared on the southern markets seemed to bear no resemblance to Eskimo life other than anecdotal content of Eskimo activities or quaint illustrations of arctic fauna. Such carvings were part of the preceding nineteenth-century trade-art tradition, but many critics of the contemporary art looked for art objects that had meaning in the daily lives of the "true" Eskimo. Art produced for the white man only—regardless of esthetic values—was therefore considered un-Eskimoan and white-polluted.

The most conspicuously misunderstood example of "pollution" concerns size and its relations to traditions old and new. In prehistoric art, small size was not only a visual characteristic but also a cultural necessity for nomadic hunters. Today, within the cultural environment of trade art and permanent settlements, the traditional size limitation is meaningless. From the financial point of view alone, large-size carvings are obviously preferable because of the higher monetary returns they yield. But quite apart from this advantage, there comes into play the liberation of the Eskimo fondness for extremes. The Eskimo delights in the impressively large as well as in the surprisingly small—in the very special and unusual as well as in the expected—as long as they are well done.

Today, the Eskimo's admiration for the very small is associated with those objects that are charm-





Artist: Johnnie Inukpuk
Port Harrison, Quebec. 1962
Stone; 19 inches high

ing rather than magically powerful, whereas the appeal of the large resides in the impressiveness and the physical power of the carvings.

Eskimo artists and perhaps artists of other non-Western cultures differ from Western artists with regard to verbalizations about their art. It is not part of the Eskimo ethic to put forth unequivocal views, and very often, out of sheer politeness, when Eskimo people talk to you they will not reveal their thoughts and opinions unless they know you very well.

The questions about art become further complicated when one realizes that there is no Eskimo word for art and that accordingly the criteria for judgment are based less on esthetics than on a kind of functional effectiveness that relates to both message and medium. The Eskimo concept of art is process- and meaning-oriented rather than directed toward the product or toward a concept of beauty.

This point needs much emphasis because it leads to an understanding of the basis of contemporary Eskimo art, which is essentially the achievement of "making" likenesses—real or imagined—that have their own reality rather than beauty. A work of art to the Eskimo is an object that is well made rather than beautiful. An essential criterion for judgment is the success of the artist in having worked the stone well, in having reacted sensitively and intelligently to the material from which the carving is made, and in capturing the likeness it was intended to be. Still further complications in understanding the Eskimo art concept become manifest in a closer examination of the Eskimos's multifaceted interactions between styles, materials, and techniques.

There are many polarities that coexist as style characteristics in contemporary Eskimo carving. They too derive from the Eskimo penchant for well-expressed extremes. Among them are symmetry and asymmetry, flatness and roundness, balance by weight and balance by gravitational forces, roughness and smoothness, stylization and naturalism, observation and invention, expression and abstraction. All these are equally typical of contemporary carving and to the Eskimo an artist's carvings must be a physical, sensuous, tactile, and intuitive response to the material.

As to techniques, an artist simply chooses the tools he likes. However, as we introduce mechanical implements to the North and educate many young people to become mechanics, the eventual adoption of power tools in art processes is inevitable. The "damage" done by electric tools is due, not to the implements' mechanical characteristics, but to the lack of sensitivity and restraint on the part of those who use them.

Incidentally, the rapid acculturation processes in today's North do not only include the obvious aspects of urbanization, such as the abandonment of camp life in favor of centralized, prefabricated settlements and the shift from subsistence economy to the money economy of laborers and wage-earners; from dog teams to snowmobiles; from hunters to office workers and dump-truck operators. The acculturation processes also generate new institutions, such as government administration (with ever-changing civil servants), schools (with ever-changing teachers), cooperatives, and occasionally some small enterprises. Yet, intrinsically and insidiously, northern acculturation implies the gradual replacement of the Eskimo language and the juggernautlike incursion of values as expressed in the mass media and in the visual environments imported to the North by white institutions, residents, and transients.

Where does this leave Eskimo art in relation to other art forms of today? In kind, it does relate to many of the art expressions in many of the developing countries. The Africans are acculturating, so are the Australian Aborigines, the West Indians, and many other peoples of the world who gained new freedoms after the Second World War. They, like the Eskimo, had old and complex traditions. Some continue with their rituals but many do not. They, like the Eskimo, have Western-culture-oriented education. Only recently have many been taking cognizance of their past culture and traditions within their education processes. And so now do the Eskimo.

Art to the Eskimo is an assertion, an affirmation, an act of faith. As such it always changes and, as long as it is able to change, it lives. Today its greatest danger comes from a commercialism that resists change or corrupts the artist into reproducing a proved product. Commercialism is a state of mind that exists as much in the producer as in the distributor. It is a sickness of our century, and it pervades most of our activities, our motives, and our institutions. Since it promises pleasant rewards, great strength and conviction are required to resist it. With the growth of commercialism in the North much of the current art productivity will disappear. But for the time being the visual arts are still powerful and lively because of the Eskimo tradition of flexibility and adaptation. If the Eskimo could not change, they would no longer be. ■

Man's Adaptable Predator

With a little help from barnyard animals, the ever changing influenza virus assures its survival by outwitting human chemistry

by Edwin D. Kilbourne

Influenza is an ancient disease that even now continues its periodic ravages of mankind virtually unchecked. At a time when such other viral diseases as yellow fever, smallpox, poliomyelitis, and measles are being effectively controlled by vaccination, influenza remains the last great plague of man—the only infectious disease still capable of spreading and infecting most of the world's population—men, women, and children almost equally—within a brief period of time.

All other contagious diseases commonly occur during childhood, at which time one acquires immunity that remains protective throughout adult life. Furthermore, these diseases occur in cycles, returning to a community when a critical number of susceptible individuals has been built up in the population by birth or immigration. But the patterns of these infections are for the most part regular and predictable and the severity of epidemics relatively constant. Not so with influenza.

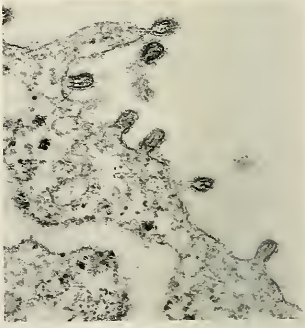
Influenza appears in three guises: in pandemic, or global epidemic, form every ten to thirty years; in circumscribed regional epidemics every two to three years; and in endemic form, affecting only a few persons, each winter. What then is influenza? In the words of the TV quiz show: "Will the real influenza please stand up."

Influenza is an acute, contagious disease caused by influenza A, B, or C viruses. The most important of these viruses and the only one that causes pandemics is influenza A virus. Although the term *influenza* is used loosely by physician and layman alike, it is not to be confused with the common cold or any of the milder infections of the respiratory tract. In its typical form, influenza is a brief but severe and incapacitating illness, which strikes with devastating suddenness and is commonly attended by fever, cough, and generalized aching. The outcome is usually benign and uncomplicated, and the patient is well again in three to seven days.

The lethal impact of influenza, due to bacterial pneumonia occurring during or shortly after the attack, is usually seen in the very young and in the elderly. Modern antibiotics have reduced the toll from secondary infections, but have no effect on influenza itself. The terrible toll of the 1918 pandemic, which killed twenty million people, would have been greatly reduced by modern drugs. The lesser mortality rates of the 1957 Asian and 1968 Hong Kong pandemics reflect, in part, the availability of antibiotics for the control of secondary pneumonia. Although influenza virus alone can kill without the intercession of bacterial invaders, lethal influenza virus pneumonia is rare and principally restricted to those with chronic diseases of the heart or lungs.

In view of the continued presence of influenza in our midst and its awesome potential for human devastation, it is a paradox that an influenza vaccine was proved to be effective thirty years ago, long before the development of vaccines for poliomyelitis and measles.

This sketchy introduction to a seemingly simple but actually very complicated disease is only to set the stage for a searching look at the villain in the piece, the influenza virus itself, which preys on man in such mysterious and capricious fashion. Although it lacks the palpability of the lion on the Serengeti Plains, being small to the point of invisibility and more changeable than a varying hare, the virus does leave its "footprints"—and even its "fossils"—so that with the help of the archeological, as well as the zoological, approach, its evolution can be traced. To use a simplistic analogy, the virus is the predator (lion) and man is at once the prey and the environment (the Serengeti). Interaction of all three components results in influenza, the disease, which cannot be understood without understanding the virus. Is the disease changeable



Six hours after infection, influenza virus particles emerge from a chicken embryo cell. Upon entering a cell a virus particle's spikes and membranes are destroyed, freeing the ribonucleic acid (RNA) strands to direct the making of as many as 2,000 new particles. After leaving the cell, new particles infect other cells, resulting in further infection until limited by the body's defense mechanisms.

because the virus is changeable?

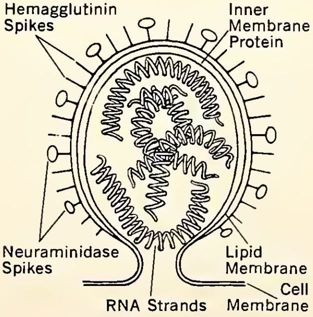
Like all viruses, and unlike the free-living microbes, the influenza virus is completely dependent upon living cells for its existence and propagation. Some viruses can range widely through the animal kingdom, finding cells in which to reproduce themselves, but the human influenza viruses are ordinarily more demanding and require human cells in which to multiply. Thus, they are obligate human parasites that cannot survive without continued access to cells in the respiratory tracts of susceptible human beings. Many other human viruses are not so demanding and can survive between epidemics by various strategems. Poliovirus can persist in the environment in sewage, yellow fever virus can be harbored in nonhuman species, and chickenpox virus can persist for years in the humans it infects. These viruses are therefore not dependent upon being continuously transmitted from person to person.

The influenza virus, however, has no place to hide; it must live in continuing coexistence with man. To do this it must be an efficient predator. It must fell its prey—certain cells of the human respiratory tract—without at the same time destroying the Serengeti Plain that harbors the prey—man himself. If the virus destroys its source of food and shelter, the living cells of a human, before it can migrate to a new source, then it cannot survive more than a few hours and will die without descendants.

If, on the other hand, the virus is insufficiently virulent and infects without provoking disease, then it also will not be transmitted to a new environment by a cough or a sneeze. Like all living things, the virus is thus subject to environmental forces upon its genes that shape its evolution to a form best equipped to survive in that environment. It must be an able, but not overzealous, predator or it will quickly die out.

Emerging Virus Particle

Mutations in influenza A virus particles are a result of alterations in the proteins of the hemagglutinin and neuraminidase spikes that enclose each particle. These alterations are directed by the viral RNA strands, shown in the center of this schematic representation of an influenza A particle emerging from a cell.



Influenza virus is admirably equipped for survival in respiratory tract tissue. It is a medium-size virus, about .0000004 inches in diameter, and its genetic material (RNA) is packaged within layers of protein and lipid, studded with spikelike projections that function in binding and releasing the virus to and from the cells it must infect. Once within the cell, the protein coat disintegrates and the RNA then directs the infected cell to make new virus particles, or virions.

The respiratory tract cells of the throat and bronchi on which the virus preys are part of its larger environment, which contains mucus and antibodies. A human being who has not previously been infected with the virus will not have specific antibodies against it, and infection and subsequent spread of virus will proceed. However, this favorable environment can and does change. After cells have been infected with the virus once, specific antibodies develop that can neutralize the virus when it next attacks and prevent it from infecting or preying further upon the cells it requires for its propagation.

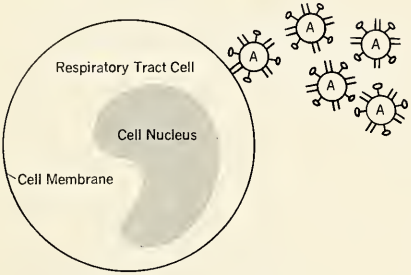
The human being containing such specific influenzal antibodies is wholly or partially immune and can successfully resist the attack of the virus. The longer the virus persists in the community, the more individuals develop specific anti-influenzal antibodies and the more difficult will be its survival in this changed and hostile environment. Unlike Kipling's leopard, the virus must then almost literally "change its spots" to survive. By some process of natural selection, a virus must emerge that can hurdle the ring of neutralizing antibodies surrounding its prey.

In 1972, as in the past, there appeared new mutant viruses of the earlier Hong Kong virus, the prevalent subtype of the present decade. These mutants, the prototype of which is a virus called A/England/42/72, can still be classed within the Hong Kong subtype, so they are not potentially pandemic strains. Changes in the present vaccine, however, will be required to provide optimal protection against them.

"The virus," of course, is not a single genetic entity but in a single infection comprises billions of particles, including mutants that arise continually but that do not become predominant or even detectable unless some change favors their propagation. Such mutants are less affected by antibodies against the prevalent virus, and thus have a survival advantage. In the new, antibody-con-

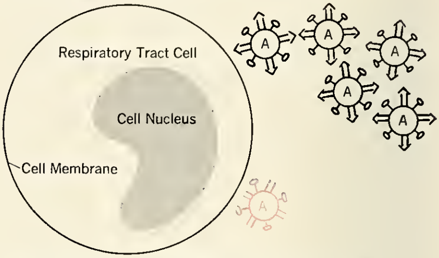
How Infection Takes Place

In the individual who has not previously developed antibodies through infection or vaccination, virus particles, in this case of virus A, attach to cell membrane, easily infecting respiratory tract cells and spreading to other cells.



How Infection Is Prevented

The immune individual is one who has acquired antibodies to virus A. These antibodies, effective only against virus A particles, bind themselves to virus spikes, preventing attachment to cell and further infection. In order to survive, therefore, the particles must mutate.



Because virus A antibodies cannot recognize viral mutant A' particles, they will be able to infect cell, thus assuring survival of the virus.

taining environment they will take the place of earlier virus strains within a short period of time. In the same way, bacteria, through graded, stepwise genetic changes, may become resistant to antibiotics and survive in the face of modern drug therapy.

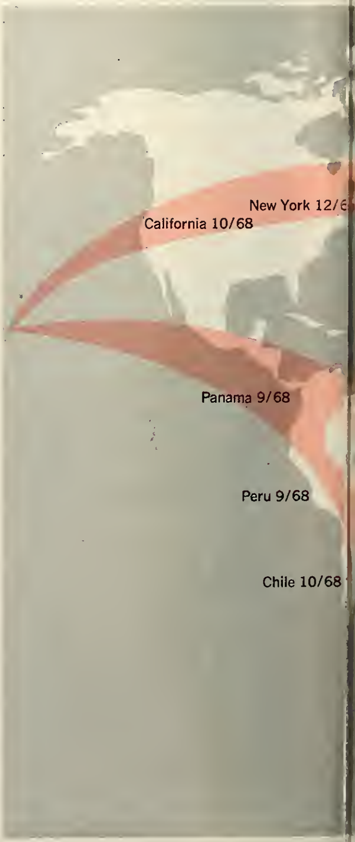
But this mechanism does not explain the sudden appearance of the very different pandemic strains of virus that periodically (approximately every decade) supplant the antecedent virus to which the population has become immune. Such pandemic viruses, which are not neutralized at all by antibodies to earlier viruses, can be shown to have very different proteins in their spikes and therefore to have changed suddenly in many different genes. Where do such viruses come from? Probably not from antecedent human viruses.

Influenza also occurs in certain domestic animals, caused by viruses distinctly different from, but related to, human influenza viruses. Animals, like man, have their own equivalents of poliovirus, pox virus and even common-cold-like viruses, but there appears to be a peculiar distribution of influenza A viruses in animal species. These viruses are not found in all species examined, and no animal has been found to have viruses that are related to the human influenza B and C viruses.

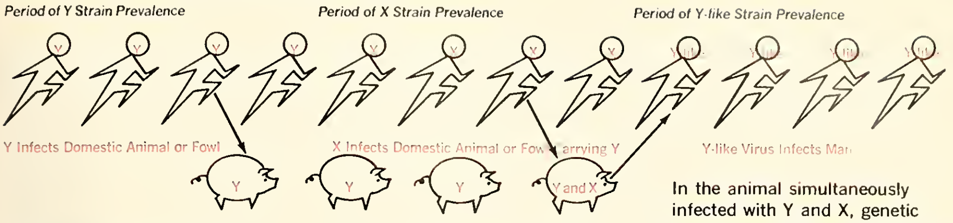
It is striking that animals that do suffer from influenza are principally domestic animals living in close proximity to man and having a manlike living pattern characterized by crowding and even indoor habitation. These species include the horse, swine, turkey, chicken, and duck.

Can it be that these so-called animal strains of influenza virus are not indigenous in domestic animals but are rather human influenza viruses that somehow leaped the species barrier in the past, thereafter to survive in domestic animals long after they were supplanted in man by new mutants? But if so, whence came the “new” mutant? I postulate that these very different pandemic viruses may represent a return to man of these so-called animal viruses when the current human virus is crowded out by antibodies and cannot survive even by gradual mutation.

There is little question that human influenza viruses can infect lower animals. Furthermore, there is strong evidence that a virus very similar to the virus of the 1918 pandemic persists to this day in swine in the United States. The human Hong Kong influenza virus, which appeared suddenly in Southeast Asia in 1968, has in-



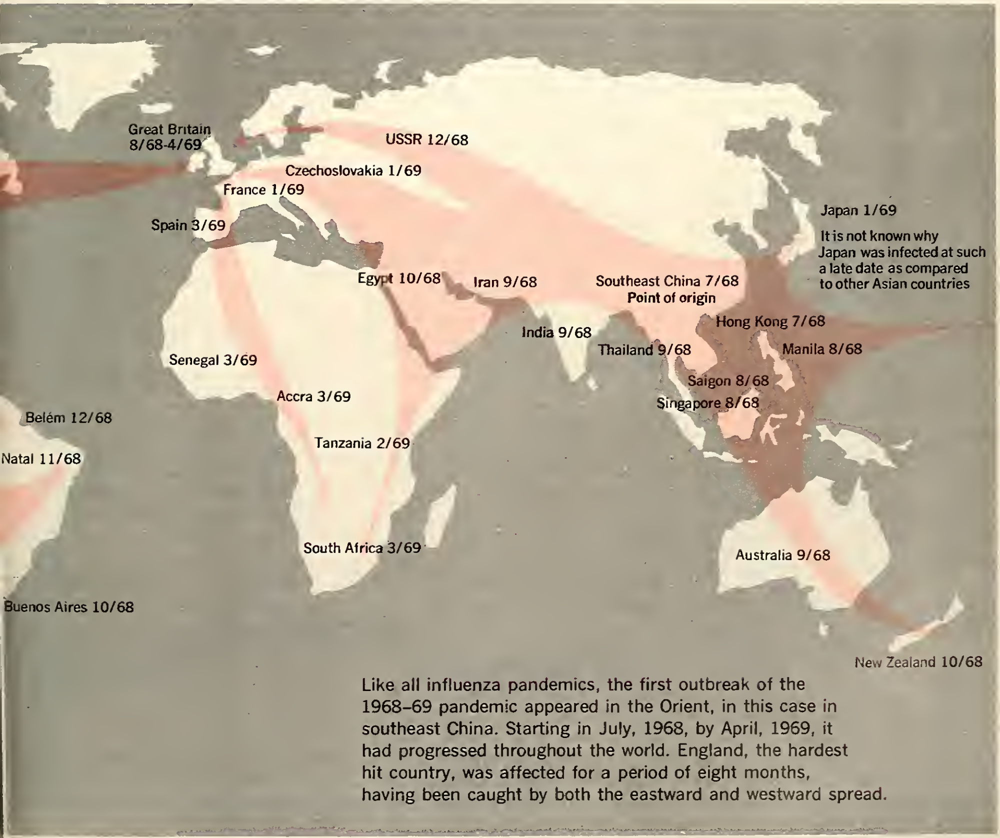
Hypothetical Scheme for the Development of Pandemic Influenza Strains


Period of Y Strain Prevalence
Period of X Strain Prevalence
Period of Y-like Strain Prevalence
Y
Y
Y
Y
X
X
X
X
Y-like
Y-like
Y-like
Y-like
Y Infects Domestic Animal or Fowl
X Infects Domestic Animal or Fowl Carrying Y
Y-like Virus Infects Man
Y
Y
Y
Y and X

The prevalent virus strain, Y, will be transmitted in man until anti-Y antibody levels become too high. While infecting man, virus Y may, in rare cases, infect some domestic animal or fowl species. When this occurs, the virus, through genetic alterations, will lose its ability to infect man.

Virus Y will be transmitted from animal to animal or from fowl to fowl. A "new" strain, virus X, will replace Y in man. Virus X may then, also as a rare event, infect a domestic animal or fowl already carrying Y.

In the animal simultaneously infected with Y and X, genetic interchange may occur to produce Y-like and X-like viruses, both of which are potentially capable of infecting man. The prevalence of anti-X antibodies, however, will prevent infection by the X-like virus. With the passage of time, anti-Y antibodies will have dwindled in the human population, thus permitting infection by the Y-like virus.


Great Britain 8/68-4/69
USSR 12/68
Czechoslovakia 1/69
France 1/69
Spain 3/69
Japan 1/69
It is not known why Japan was infected at such a late date as compared to other Asian countries
Egypt 10/68
Iran 9/68
Southeast China 7/68 Point of origin
Hong Kong 7/68
India 9/68
Thailand 9/68
Manila 8/68
Senegal 3/69
Saigon 8/68
Singapore 8/68
Accra 3/69
Belém 12/68
Tanzania 2/69
Natal 11/68
South Africa 3/69
Australia 9/68
Buenos Aires 10/68
New Zealand 10/68

Like all influenza pandemics, the first outbreak of the 1968–69 pandemic appeared in the Orient, in this case in southeast China. Starting in July, 1968, by April, 1969, it had progressed throughout the world. England, the hardest hit country, was affected for a period of eight months, having been caught by both the eastward and westward spread.

fected swine in many parts of the world. The Hong Kong strain, incidentally, has a certain chemical resemblance to an equine influenza virus first isolated in 1963. Some influenza viruses of domestic fowl are chemically related to certain human strains. Thus, the links between human and animal viruses are real, not merely hypothetical.

But how does the animal influenza virus jump the species barrier to return to man in pandemic form? Infection of man by animal influenza viruses has rarely been demonstrated. Thus, animal influenza viruses, possibly once human influenza viruses, appear to be adapted to their hosts and deadapted to man.

The answer may be found in another unusual characteristic of influenza viruses: their ability, seen in laboratory experiments, to recombine or hybridize with one another by exchanging or reassorting their genes—pieces of RNA—within the cells they infect. This process results in progeny virus that, like human offspring, differs from both parents, having genes from both. This genetic mechanism provides the evolving predator with the capability—not possessed by the predators of the Serengeti—of adapting instantly to a new and unfavorable environment, human cells, instead of taking millennia to do so.

Influenza virus may thus be unique in having what could be termed an extended gene pool upon which it can call as necessity demands, that is, after it has changed its own environment by infecting man and raising an antibody. If human influenza virus should, however minimally, infect an appropriate domestic animal, then there may well be genetic in-

Following the Footprints of Influenza in New York City

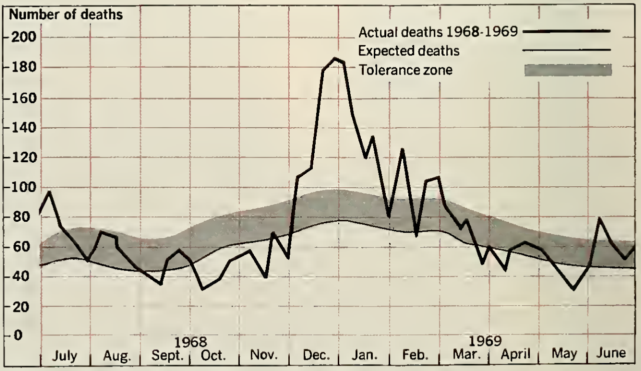
New York City is an ideal environment for the survival of a specific influenza strain, especially during the winter months. Once introduced into the city, the virus finds the highly dense population easy prey. Through a sneeze or a cough—in crowded schools, office buildings, stores, buses, and subways, the virus' hunting grounds—particles are able to jump from respiratory tract to respiratory tract. The virus almost cannot help but survive until antibodies appear in the population. Even after formation of antibodies, mutations of the prevalent strain will have a good chance of surviving in the dense population, thus assuring that a certain influenza strain will always be present.

Public health officials are always greatly concerned about the possibility of an influenza epidemic. But how, in a teeming, mobile population of a large metropolitan region, do you determine when an outbreak of the disease has become so serious that the public should be warned?

The effects of influenza, having been felt and observed year after year, are well known to most individuals: several days of aches, coughs, and fever, which, although they cause a great amount of occupational absenteeism, in most cases are not serious enough for medical treatment. For this reason, tracking down the extent of influenza infection in the city over a specific time is difficult. In New York City, however, the Bureau of Infectious Disease Control of the city's Department of Health employs several methods to detect both the number of cases and the type of influenza strain.

The bureau has become an influenza detective agency, using a surveillance system involving seven distinct activities: hospital surveillance; monitoring of industrial, public services, and school absenteeism; tabulating pneumonia mortality; and performing viral isolation and serologic studies. The watch on hospitals and absenteeism is carried out from November through February, the months corresponding to the peak influenza season, while the other monitoring takes place throughout the year. The combined parts of this surveillance system provide data reflecting the amount of influenza in the city.

When influenza enters a community, one of the first changes noted is an appreciable rise in the number of patients seen in outpatient clinics and emergency rooms. To monitor such rises, fifteen hospitals in the city, three in each borough, are contacted by telephone on a weekly basis and the total number of outpatient and emergency room visits are obtained. Through this surveillance method, weekly changes can be observed for the city as a whole,



Pneumonia deaths in New York City in 1968–69, showing the increase as a result of the pandemic.

teraction of that virus with anachronistic, or "dinosaur," human viruses carried in that animal. The progeny of this interaction might then contain genes from the animal virus, to provide it with a brand new coat not "recognized" by a prevalent human antibody, and genes from the human virus, to endow it with human virulence. *Voilà,* the new pandemic strain.

The probability of interaction between human and animal viruses is increased in proportion to the frequency of human–animal contact. Such contact occurs in places like rural areas of Southeast Asia, where man lives in close proximity to domestic animals. In this connection, it is notable that most pandemics of influenza appear to have originated in Southeast Asia, perhaps in China.

Thus, influenza virus, the evolving predator, will continue to evolve, only to be temporarily defeated once again by its own excesses as the human population forms antibodies against its onslaught, and so on, ad infinitum.

But man has never been helpless against predation and certainly he will eventually contain the predations of influenza viruses. Advantage has already been taken of the genetic plasticity of influenza virus in making new vaccines to artificially stimulate immunity against the virus. One such vaccine contains a man-made recombinant virus that grows abundantly, resulting in high production yield and great economic saving. Another, live-virus-mutant vaccine produces infection and immunity without disease. Perhaps the very tricks used by the virus for its survival can be used by man for its eventual conquest. ■

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by Pascal James Imperato

as well as for specific parts of it.

Weekly contact is also maintained with New York City's ten largest corporations, which together employ 150,000 people. The number of persons absent per week, as well as the number of man-days of work missed, are obtained from each of these corporations.

To supplement these figures, the two largest public service organizations in the city, which jointly employ 50,000 persons, are also monitored each week. The data obtained from them reflect absenteeism among civil service workers as opposed to those working in private industry.

Although influenza affects all age groups at the onset of an epidemic, the infection rate is highest among primary and secondary school children. Thus, this population serves as a good index of influenza activity. Twenty-five schools, five in each borough, participate in the weekly influenza surveillance activity, providing absenteeism data on approximately 20,000 children. Five of these schools, one in each borough, are contacted on a daily basis.

Another clear measure of the amount of influenza activity is the increase in the number of deaths from pneumonia. Death certificates are filed with the Department of Health, and the number of deaths due to pneumonia are tabulated on a weekly basis throughout the year. The normal curve of this mortality statistic for the city is one in which there is a gradual rise starting in October and reaching a peak during the third week of January. Because pneumonia is often a complication of influenza and clinically causes death about two weeks after the onset of the original influenza illness, an increase in the expected number of pneumonia deaths at a given point in time usually reflects the influenza situation of two weeks before. An exception to this occurred this past summer during the last week in July, when the actual number of pneumonia deaths rose to 108 from the expected number of 55 to 70. This unexpected rise, which occurred two weeks after a prolonged and severe heat wave in the city, was due to deaths among individuals suffering from pulmonary disease.

During the entire year, nasal and pharyngeal secretions, as well as other materials, are submitted by private physicians and institutions to the virology laboratory of the New York City Health Department. Influenza virus can be grown from such materials in either tissue culture or embryonated hens' eggs during the early febrile stage of the disease, thereby permitting further laboratory studies to accurately identify type, subtype, and strain.

Also throughout the year, thousands of blood specimens are submitted to the department's laboratories for a variety of studies. On a monthly basis, samples of sera from these specimens are tested for the presence of hemagglutination-inhibition antibodies to influenza virus. Early this winter, 48 percent of all sera tested possessed demonstrable antibodies, reflecting a high level of immunity in the city to current influenza virus strains. A year ago, however, only 28 percent of the sera tested possessed antibodies; this increase in the rate of immunity is the result of local influenza outbreaks during the winter of 1971–72.

Although not entirely accurate, surveillance methods are the most effective means of determining the severity and longevity of an influenza outbreak. When absenteeism decreases and the pneumonia death rate returns to normal, it is evident that the population has formed antibodies to prevent further infection. The virus strain can no longer survive in the population. But when absenteeism and pneumonia deaths again increase, it is a sign that the virus has successfully evolved a different strain or a mutation, for which present antibodies are not effective.

Without high-powered microscopes, we cannot see the influenza virus, but we can quickly learn of its presence in New York City by watching the shadow of suffering and death that it casts. ■

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The People Crunch Comes to East Africa

Continued from page 16

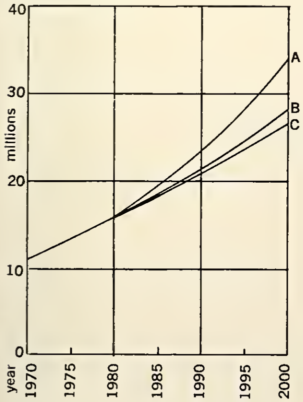
trators. It looks now as if most of the excision will be returned to the park, and "alien" use will be limited to grazing, which is not nearly as antipathetic to park purposes as cultivation. But the local people clearly do not see the park meeting their daily needs, particularly when the proceeds from the 60,000 annual visitors go off to the national exchequer in Dar es Salaam. Unless Tanzanians can be persuaded to view their park as something integral to their individual lives, as well as to the national image, this recent incursion into park territory must be seen as a not-so-thin edge of a very powerful wedge.

Similar problems face Ngorongoro Crater. While nobody is planning to plant the place to wheat in the foreseeable future, and the few Masai in the crater live amicably enough with the wildlife, the crater's water balances are critically dependent on watershed territory twenty miles away. If the forests of that catchment area were chopped down, the timber would produce good revenue and the land would support fine crops for some time. It would be hard to persuade someone bent on such an exploitation scheme to drop it for the sake of animals that do not apparently provide him with much direct income.

As nearby Lake Manyara National Park, zebra and wildebeest have virtually disappeared since their grazing grounds along the lakeshore disappeared under floods ten years ago. Although the waters have receded somewhat, there has been no chance to build up the remnant herds because the animal migration routes into the park have been blocked by recent human encroachment. Elephants have become effectively trapped in

The high cost of irrigation throughout East Africa prevents sizable increases in the amount of arable land. As the trend toward fewer acres per capita accelerates, the national parks become increasingly vulnerable to exploitation schemes.

Projected Population Growth for Kenya

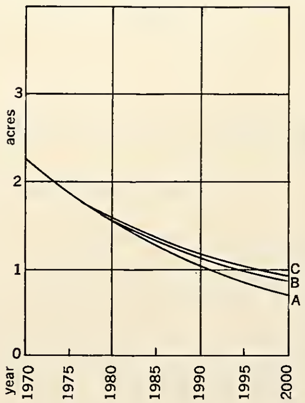


Notes: A—no change in present number of children per family (7.6)

B—fertility rate of four children per family

C—fertility rate of three children per family

Arable Land Per Capita



Notes: based on a present arable land total of 24,855,000 acres, and corresponding to population projections.

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We searched many, many months for the dream place in which to set our dream . . . and at length we found it. Unmistakably, this was the land—land green with health, rich in lakes, bordering the vast natural beauty of Ocala National Forest, edged by the lazily-flowing Oklawaha River. A gentle land where birds gather and deer live, where the sensual colors of hibiscus, oleander and bougainvillea splash the scape. A haven to run away to, yet not that far away as to close one's self off from the conveniences of modern living. For set off though we are, the entrance to our property is just four miles from Silver Springs itself, Florida's claim to a world wonder. And three miles away is downtown Ocala, one of the state's fastest growing towns.

Nature having preceded us, we moved quickly. We lifted our dream from the drawing-boards and put it into life on the ground. We spent money—a great deal of money—for talent, for materials, and especially on the land itself. We won awards—commendations which say that we, more than all others, had joined with nature in a harmonious partnership, bringing forth a community in which *we* could rightfully take pride and *you*, joy.

Very sketchily, in the short space we have, and before we talk about the condominium that this advertisement is about, let us list part of what we've already done here. The land is beautiful and we've designed everything built on it to preserve, even enhance, that beauty. We're phobic about chopping down trees; our thing is to plant, not cut, and our landscape nursery is worth a visit in itself. Our paved roads are expensively curvilinear. The magnificent 18 hole, 7151 yard championship golf course is wrapped around 6 lakes and is considered the masterpiece of world-famous golf architect Desmond Muirhead. We have a Beach Club at Lake Smith and a Yacht Club at Lake Weir (fishing here is truly incomparable). Altogether, there are 19 glistening lakes of which 14 are totally

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within the perimeters of our property. We built a 100 room hotel, community clubhouse (fully staffed), civic and shopping centers. We've provided swimming pool as well as lake facilities. The substantial firms who have come into our industrial park not only offer bright opportunities for employment (thereby establishing a wide range of ages running from young marrieds to retirees) but have designed their operations to conform strictly to our nonpollutant requirements.

There's a good deal more to tell of this master-planned community, into which has been put more than 10 million dollars in *improvements alone*, and of N. Y. Stock Exchange listed AMREP Corp. whose experience and reputation for integrity are backed by assets of 170 million dollars. Much more to tell... but it's that condominium you want to hear about and we'd better get on to it....

In your mind's eye, stand with us here on the flower-framed terrace that leads from the living-room of your condominium apartment. Let's watch together as darting bass burst the bright surface of the lake. Step down and walk with us the few yards that bring you to the edge of a manicured fairway of what leading professionals have described as "one of the world's finest golf courses...." You think how lovely it is, how tranquil. How it all fits: the natural scene and this condominium home of yours; their grace, so deceptively simple; their setting, the fabric of those two marvelous collaborators, nature and man.

And you wonder, as you surely must, how it became possible for you to have your own home in this luxurious landscape for so little money. Those apartments we're describing are typical: a one- or two-bedroom carpeted and air-conditioned condominium with large living-room, fully equipped kitchen, 1 or 2 baths and a wide terrace allowing a close-up view of lakes and golf course. No use attempting here to list in full all of the superior equipment that gives these apartments such palpable quality. You'll find that information in full detail in the *free* portfolio that we're asking you to write for. It will show you in color—in photographs and renderings—what we're doing here at THE FAIRWAYS AT SILVER SPRINGS SHORES and why we're so proud of it. You will get floor plans of all of our models and actual photos of our sites, permitting you, therefore, to *choose* where you want to reserve your home. There will be maps, fact sheets. But whether or not you'll purchase, we wish most to have you understand very clearly what manner of home we are offering you and why, in this era of soaring price tags, *our* prices have been brought *down* to a level which should be in the range of your means.

So we say to you in candor that when this splendid golf course was designed to thread its way through and around those six lakes, our original plan was to sell at expensive prices a limited listing of prime lots that hugged shores and fairways. We laid out these sites to attract a relatively small number of affluent purchasers who would have the means to afford them, each of whom would be required to build his home on them within a specified and early time. Did we say these lots were expensive? You may believe it—up to $30,000 for a single homesite, but that seemed to be no deterrent. Buyers came, but (remember: we promised to be candid) we found that while purchasers for *lots* were plentiful, guarantees to immediately build *dwellings* were not. And even though some fine homes have indeed gone up, it became clear—to put it in plain words—that most shrewd purchasers were attracted to these lovely sites because of their *obvious speculative* value. High-priced though they were, these lots were still very much a bargain, difficult to be matched elsewhere except at fearful cost. Of course, *we* knew how valuable they were, and if it was just *selling* land that concerned us we could have moved them quickly. But merely selling lots was not our intention; it wasn't speculators we wanted to attract. We wanted *residents* here, not empty spaces to be held out for resale profit alone. Homes, people living in them. We wanted people to play on our golf course, swim in our pools, fish and sail in our lakes, come together as friends in our Country Club and community centers. It is as builders of communities of outstanding ambience, not as peddlers of parcels, that our company has become what it is.

Abruptly, we changed our thinking. To condominiums....

Simply stated, what you can buy in these condominiums on THE FAIRWAYS AT SILVER SPRINGS SHORES is a home on the very same site that originally had been planned for sale to a wealthy man. That which *he* would have acquired can instead be in part *yours:* the loveliest setting and most valuable real estate worth that SILVER SPRINGS SHORES can offer. And we are assuring the continuing superlative quality of this area by insisting that our architects and builders produce structures that stress esthetics and value, not profit. The buildings will be one- and two-story, not high-rise. Two-thirds of each area is preserved for lawns and gardens and for recreation and play. Our swimming pools won't be just bodies of water; their *design* will give you pleasure. In a word, we're putting into these condominiums more than you might have dreamed your money could buy.

Please consider then: we're informing you that you may own an elegant condominium apartment whose style is instantly seen to be of the highest and most tasteful worth. And then we go on to tell you that such a one-bedroom home will cost you only $19,950; a two-bedroom, two-bath apartment is as low as $22,950. The monthly maintenance quoted in the headline, as low as $32—no higher than $64—leaves you virtually no responsibility except for the *inside* of your place. Maintenance takes care of the *outside*. Financing is available up to 80% mortgages to qualified purchasers.

As has been said of condominiums: turn your key and come or go as you wish. It may be your permanent home or simply yours to come to when and for how long you choose—knowing all the time that it is being carefully attended to. We are in a region whose real estate investment character is regarded as among the most attractive in Florida. The opening of Disney World—some 65 miles from our property—has brought new growth to central Florida's land values. We don't loosely promise that you can rent your apartment whenever you wish but it is nothing less than the truth that rentals in the region are in high demand. And THE FAIRWAYS AT SILVER SPRINGS SHORES has more than the ordinary going for it. The great golf course is a major focus for the discriminating golfer. He wants to come for a stay, pay greens fees and play this magnificent lay-out. He is permitted to do so as a guest by renting a member condominium owner's apartment. Your membership? Your condominium? Shall we help you arrange it?

With all we've said here, there is so very much more you'll want to know. Your mailman can help. He can deliver to you a portfolio we've prepared, deep with information, plans, maps, photographs. This is free for your asking and, of course, commits you to nothing. In fact, you'll never be committed to anything until you sign a contract and have been provided with full information relative to our condominium project as required by the statutes of the State of Florida. Our literature will tell you how to go about reserving your condominium by mail through a small, refundable-at-will, deposit. It will show you how you may reserve an apartment of your choice and it will guarantee that you will have four full months to come to the property to exercise that reservation. We don't limit our guarantee to money refunds; we tell you also that the reservation you make by mail guarantees the reserved price, regardless of later increases that rising construction costs could bring about.

And finally, at the risk of arousing your skepticism (you've heard this before, of course) we do tell you that we have planned only a limited number of prime condominiums, and that they are buys so patently outstanding that they will go very quickly. Thus, we urgently advise you to fill out the coupon and mail it right away. Our information first, your visit to SILVER SPRINGS SHORES later—these will permit you to judge for yourself the strict truth of what we've said.

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the park also, and the patches of *Acacia tortilis* forest are not likely to survive another ten years under their foraging pressures.

The key to safeguarding these dwindling game lands is to get them to provide a greater return for a larger number of people through wildlife protection than through alternative forms of land use.

But as people in East Africa become more hungry for food and land, they will look askance at any further schemes for keeping chunks of the landscape locked up for the delight of foreigners. Uganda has denied itself the hydroelectric power of Murchison Falls for the benefit of tourist spectators who will not arrive in large numbers for a few years yet. Should Kenya, by the same token, deprive a hundred Masai families of their rights in the hinterland of Nairobi National Park against the promise of better times for all of the Masai's fellow countrymen? Should Tanzania have to continue subsidizing some of the world's foremost wildlife spectacles when it is about the least able of the world's countries to afford it?

Kenya is trying to do something about its population problems. It has instituted an official family planning program, and while this is far from the same as population planning, it is still an advance of the first order. But Kenya has only been able to allocate the equivalent of five cents per capita to family planning, or 0.25 percent of its health budget and 0.02 percent of the national budget. The compelling reason behind such paltry funding is that there is only one doctor for every 11,000 people and the medical profession's priorities are to keep people alive until the ripe age of forty-five, and to keep at least three out of four children alive until puberty. The task of preventing children being born in the first place has been subordinated to immediate health needs. This is why the family planning program reaches only one, or at the most two, out of every 100 women of child-bearing age as compared with India's ten. Studies done by the Population Council of New York indicate that further programs must be greatly increased before fertility can be stopped from rising.

Advice from outsiders, however, is going to be suspect, especially when that advice, tied to a philosophy that focuses on the intrinsic beauty of a rhinoceros, apparently undercuts the basis of their precarious subsistence. Until East Africans can believe that conservation is to be undertaken for local people, not despite them, reactions to proposals made by foreigners could become increasingly hostile. Appeals for population controls may be met with uneasy thoughts of genocide, and all wildlife viewed simply as attainable protein.

Continuing to rely on the faulty assumption that the increasing influx of tourist dollars and conservation donations will assure the survival of the waterbuck and cheetah is inviting their extinction. Not only do the people most directly affected by wildlife conservation programs receive the least direct benefit from them, but the increasing impact of thousands of tourists and their landscape-altering vehicles may create more havoc in some local environments than any poacher ever did. Rational efforts at conservation, based on the premise that only governments that can satisfy the basic needs of their citizens can afford the luxury of conserving wild animals, are desperately needed. To this end, nations like the United States should at least restore their recent foreign aid cuts, considering the funds as, in part, the rest of the world's share of the costs of protecting the world's wildlife.

Aid aimed at agricultural and industrial development could also help, in that the recipient nation will be eventually better able to provide for its citizens. It is possible that the new United Nations environmental agency based in Nairobi could effectively set up multilateral programs aimed at achieving certain forms of economic development and population control in a relatively short period of time. But action is needed soon; after millennia of evolution, the animals may become extinct during the next twenty critical years, because the growing, land-hungry population will be forced to settle the last open areas of a once vast continent. ■

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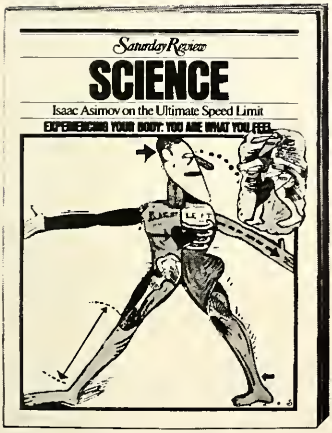

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Black Holes and Galaxies

One of the problems with big bang cosmology has been to explain how the galaxies accreted from radiation and matter streaming out evenly in all directions from the initial blast. Present theories postulate small inhomogeneities in this outward stream, in which slightly denser portions of the stream began to exert gravitational pull on nearby matter. But it is hard to show how very small differences could account for the accretion of matter equal to 100 million suns in our galaxy, for example, in the 10 billion years or so we believe have elapsed since the big bang.

But if black holes existed very early in the history of this universe, perhaps since the explosion itself, they could more than account for the gravitational attraction necessary to form large galaxies. Michael P. Ryan, Jr., of the University of Texas has computed that a black hole of one to nine million solar masses could account for the accretion of our galaxy. Writing in *Astrophysical Journal Letters*, he goes on to suggest that every galaxy with a mass of 10 million suns or more may have a black hole at its center. Smaller galaxies could have accreted in the last 10 billion years without the help of a black hole. There is some physical evidence pointing to a large black hole at the center of our galaxy. The gravitational waves detected by Joseph Weber at the University of Maryland appear to be coming from the center of our galaxy, and a number of astrophysicists have ascribed them to a black hole.

A Job for Amateurs Serious meteor observers are invited to join a new International Centre for Meteor Observations being established by the British Astronomical Association. Amateurs are needed to take over some of the jobs professionals have been forced to abandon.

At a meteor conference held by the International Astronomical Union in Albany in 1971, the professionals pointed out that some of the sophisticated photographic and radar programs started since World War II have been curtailed. They added that amateurs, if properly coordinated, could provide a worldwide patrol to keep a routine watch on meteor activity. During periods when unusual and interesting activity was expected, an almost continuous 24-hour watch could be maintained.

Keith B. Hindley, director of the BAA Meteor Section, emphasizes that the new center is not designed to replace existing meteor organizations, but to complement their work and lead to better international cooperation. Members will receive information through the section *Bulletin*, the magazine *Meteor News*, edited by Karl Simmons and published in Jacksonville, Florida, and through the IAU *Circulars*.

The ideal of worldwide coverage is limited by the location of the world's land masses. Even so, some places are better covered than others: England and eastern North America are well covered; most of Asia is not. There are essentially no observers near the Equator, although the highest rate of meteor activity can be expected in that region. Because meteors, unlike celestial objects, cannot be seen more than a few tens of miles away from where they enter the universe, more observers are needed almost everywhere on the globe.

Meteor observers, whether organized in groups or acting as individuals, are invited to contact the international center through Dr. Keith B. Hindley, Department of Organic Chemistry, The University of Leeds, Leeds LS2 9JT, England. There is no charge for membership. Each member will receive the BAA meteor *Bulletin*, report forms, notes on observing methods, and advice on meteor work in general. The center will be run as an experiment for three years; if it succeeds, it will enable amateurs to make astronomical observations of scientific value.

Southern Exposure Like their counterparts in the United States and in Europe, Canadian astronomers want a better look at the still largely untapped riches in the southern sky. A group from the University of Toronto, working at Las Campanas in Chile, has made a couple of discoveries in recent months with a 24-inch reflector, a quite modest telescope by professional standards, and they want more.

Robert F. Garrison, recording the spectra of luminous young stars in the southern sky as a part of a program to map the spiral arms of our galaxy, has found a very rare type of star composed almost entirely of helium. Most new stars are composed primarily of hydrogen; thermonuclear reactions in the center of the star convert this to helium. When the hydrogen is exhausted, the core contracts, heating up in the process until it is hot enough for thermonuclear reactions involving helium to take place.

As such a star heats up again, it expands, with the outer surface remaining fairly cool. At this stage it is known as a red giant. The star found by Garrison, however, is not giving the cool, red light of

by John P. Wiley, Jr.

Visual observers record meteors from the Springhill Observatory about 25 miles south of Ottawa. Their results are combined with radar and spectrographic data by the National Research Council of Canada.

such a giant, but a very blue, hot light more commonly associated with a white dwarf. Garrison feels this star could represent a missing link in our understanding of stellar evolution.

Report of the helium star is the second time the Toronto group has made the news from Chile this year. Last spring they photographed one of the brightest supernovae seen in this century ("Sky Reporter," November, 1972). Neither object could be studied from the latitude of Toronto.

Donald A. MacRae, chairman of the University of Toronto's astronomy department, commented that the southern sky has a great deal of excitement to offer. "Canada's astronomers," he said, "are hoping that they will some day have a larger eye in the southern hemisphere so that they will not have to leave to others the follow-up work on their own discoveries."

Outer Limits Ever since the British journal *Nature* split into three publications, the general Friday edition has carried teasers for the highly technical physical science edition published on Mondays and the biological science edition published on Wednesdays. It is in these teasers, which always precede publication of the full paper, that an idea of the thinking at the outer limits of astrophysics can be acquired.

In early November, for example, there was a teaser for a paper on the background radiation that seems to fill the universe. This microwave radiation is commonly explained as the remnant of the big bang from which our present universe emerged. But there may be another, gaudier explanation. Suppose, as many do, that the universe is oscillating: there is a big bang, expansion of the universe, a gradual slowing down, and then a collapse in on itself as gravity overcomes the outward expansion, until the entire universe compresses into one glowing mass, which then explodes in another big bang. No one is sure that the physical laws we know will remain constant in each succeeding universe. Perhaps electrons will have a positive, instead of negative, charge the next time around.

The paper summarized in the Friday *Nature* suggested that in each successive universe, the direction of the arrow of time may be reversed. In the next universe after this one, time may have flowed in the opposite direction. Thus, the radiation we see today is the starlight of a universe that has yet to be, scrambled and made isotropic by having passed through a big bang.

Such a theory explains the current coincidence that the background radiation we see matches the energy density of the starlight from this universe. And, as the editors of *Nature* comment, the theory "has the merit, not shared by many cosmologies, of being tied directly to a measurable physical property of the universe."

In another teaser later that month, I was disappointed to learn that it is not practical to extract energy from black holes by lowering things into them on ropes. It was a fascinating idea, because theoretically it was possible to exert energy of up to mc^2 on the operator's end of the rope. But the paper to be published the following Monday was to show conclusively that even an idealized rope—one that would not be affected by the peculiar properties of space-time around a black hole—would break before the lowered object reached the zone where its weight would become infinite. For a practical rope (the author considered piano wire), breakage occurs much sooner. Back to the old drawing board. ■

Celestial Events

by Thomas D. Nicholson

The Moon At mid-January, you will find the waxing gibbous moon well up in the southeastern sky in the early evening. By the 18th, it becomes full, rising well to the north of east at sunset, remaining all night long, and setting to the north of west at sunrise. Thereafter, the waning gibbous moon rises after sunset, becoming the last-quarter moon on January 26. In the morning sky as a crescent in late January and early February, the moon becomes new on February 3. By the 6th of February, you will see the early crescent in the western sky at sunset, appearing higher nightly. First-quarter moon is on February 10, and the waxing gibbous phase remains in the evening sky through midmonth.

Stars and Planets The bright winter stars are in full display now, filling the eastern half of the sky during the early evening, rising up into the south by midnight, and moving into the west as dawn approaches. The stars of the autumn, dominated by the Square of Pegasus, are in the west after sundown, but have just about gone below the horizon by midnight. If winter is beginning to tire you by now, a glimpse at the morning sky may be heartening. Just before dawn, you will find the brightest of the summer stars—Altair (close to the horizon), Vega, and Deneb—bright and high, forming their great triangle just to the left of east.

Saturn, now the only planet to look for in the evening sky, is well up in the southeast among the stars of Taurus after sundown. Mercury is also an evening star after January 28, but not in position for viewing. In the morning, Saturn will still be visible low in the west until just before dawn, Mars rising in the southeast with Scorpius as the sky brightens. Jupiter and Venus, both morning stars, rise too late in the dawn to be seen, although by mid-February you may be able to see Jupiter rising about an hour after Mars.

January 15: After sundown tonight, look for Saturn below and to the right of the waxing gibbous moon. You will clearly see the moon separating to the left from Saturn during the night.

January 16: The moon is at perigee, the point in its orbit where it comes closest to the earth.

January 18: A penumbral eclipse occurs at full moon today, but produces only a slight dimming of the moon's brightness.

January 28: The moon is now at apogee, where it is most distant from the earth. Mercury is at superior conjunction and enters the evening sky.

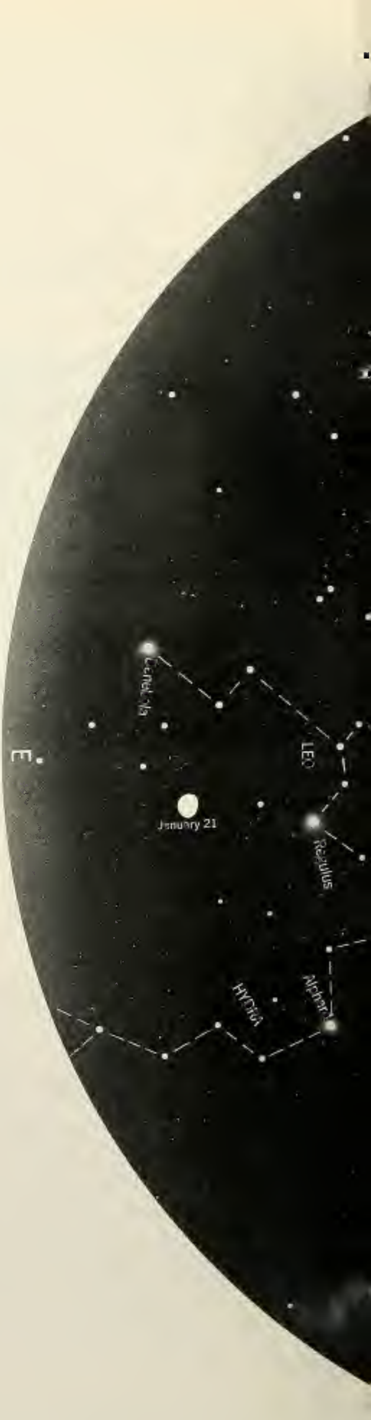
January 30: Mars will be above the rising crescent moon in the sky this morning.

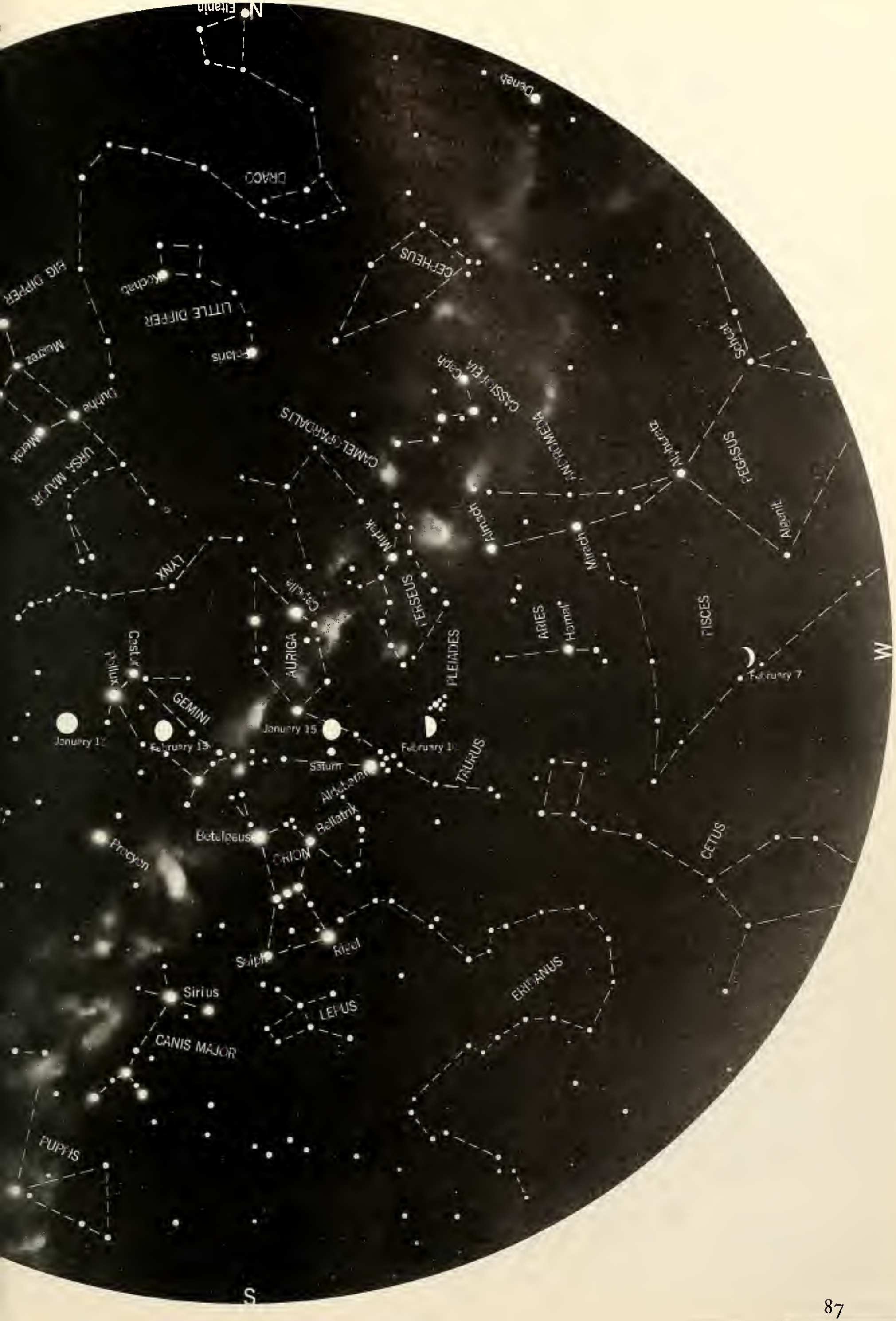
February 1: Jupiter and the moon are in conjunction, and the moon occults the planet over the North Pacific and northwestern North America. But Jupiter rises too late to be visible.

February 11-12: You will see Saturn near the gibbous moon on both evenings, below and to the left of the moon on the 11th; above, to the right of the moon, and more distant on the 12th.

February 13: The moon is at perigee, nearest to the earth. Saturn has been approaching the star Aldebaran, in Taurus, as it moves westward in retrograde motion. Today, the planet becomes stationary in Right Ascension, resumes its direct (easterly) motion, and begins to move away from Aldebaran.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:15 P.M. on January 15; 9:15 P.M. on January 31; and 8:15 P.M. on February 15; but it can be used for an hour before and after those times.

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S

by Luther P. Gerlach

The Prophet Speaks

Where the Wasteland Ends, by Theodore Roszak. *Doubleday & Co., $10.00; 492 pp.*

Let us boil down the history of the United States since the early 1960s to a few key aspects. First, there was the time of contentment; the United States seemed to bestride the world mightily and confidently. Some American leaders, including President Kennedy, felt compelled to urge Americans to cast off their complacency and help change the world into the American image.

Then, in the mid-sixties, spurred by the Vietnam war and by the rise of Black Power, Americans in the established order began to question and even to reject this order. Some dropped out from it, others organized against it and assaulted it. Increasingly, Americans found monstrous defects that laid the established order open to assault: racism, the military-industrial complex, counterinsurgency and intelligence operations, the dreadful war in Indochina, and environmental rape and pollution.

Across the country, people participated in myriad groups to protest these and other defects in the conventional culture. It was a rising movement of national soul-searching and contravention of convention. Perceptively, Theodore Roszak called this movement "the counter culture" in his 1969 book, *The Making of a Counter Culture.* He summarized many of its main features, dislikes, and desires. He indicated empathy for it, but also suggested that he was himself more interpreter than participant.

Almost before *counterculture* became a household word, a new element had been added to the forces changing the United States. Americans moved forward from merely countering the established American system. They began to suggest myriad alternative lifeway patterns and to experiment in the implementation of some of these. Across the country, people explored new modes of marriage, family, and community; new role behavior and different patterns of interpersonal relationship; new forms of education; new means of producing and distributing food; new political forms; new means of achieving religious experience; new technologies, such as those that will help conserve energy and resources; and new ways of relating humankind to biophysical environment.

Some sensed—or at least hoped—that this was part of a dynamic of change that would transform the Western world and bring it to a new era. But what kind of an era? On the heels of the alternatives movement came the new "futurists." Unlike traditional futurologists, they do not wish to limit their projects to lineal extrapolations from the past. They are willing to imagine many different types of social-cultural systems, considerably different from those the United States has experienced.

But these new futurists seem unwilling just to let the myriad alternatives and experiments spin off in all directions. Instead, they seek to find the gestalt, or general principle, that already integrates or can integrate these diverse elements. They have visions of a new utopia or, at least, a better order of things. They project from these multiple social mutations and variations an immanent configuration. Some of these futurists, scrapping scholarly detachment, militantly crusade for the implementation of their special image of what the United States—and the world—should be, must be!

Roszak presumably shares the view that the United States, if not the entire Western world, is experiencing a time of transformation. He presumably hopes that his most recent book, *Where the Wasteland Ends,* will not only explain and exorcise the evils of the traditional American system, but will also set people on the right course to discover the way to the promised land. Now, however, he is no longer simply the sympathetic interpreter of segments of the counterculture. He has three new roles: (1) evangelist, who portrays vividly the evils of the present and the desperate need for change to avert doomsday; (2) prophet, who foresees great new experience and special knowledge if change occurs and ruin if it does not; and (3) a cautious and humble, but visionary, leader, who suggests how the movement will make change and what form the future will assume.

Let us examine these roles and their meaning: first and foremost, Roszak is the prophet who explains to people the true and awful significance of the established "technocratic" and "urban-industrial" order to which they are sadly "addicted." He warns them that this order keeps finding new ways to trap them in spirit-destroying affluence and to trick them into forsaking experience in the real and natural environment in order to wallow in the phony pleasures of the "artificial environment." He explains that worship of this man-made environment is the true and awful idolatry. He finds use of the objective scientific method to be the most sinful activity of this technocratic order, for it imposes upon those who follow it a "single vision" that prevents them from seeing and experiencing the world in other, more enriching and enlightening ways.

Most of the book is devoted to

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this assault upon convention, this identification of our sins and of the demons that hold us in bondage. And it is well done. Roszak knows his history of science, and he knows how to select from this history that which will advance his cause. He understands that the scientific method is at the driving core of Western culture and that it has given Western peoples great power. He identifies the root of this power as flowing from "a simple willingness to break faith, to harden the heart and abandon the fellowship of feelings." Science gives "you" an "ethic of alienation," by which you can "break faith with the environment, establish between yourself and it an alienative dichotomy called objectivity," and treat people and environment as "mere things on which we exercise power." Strong stuff, this, with so much truth in it that it is bound to raise cries of anguish from those scientists who feel that they temper their objectivity with "humanism."

Roszak is at his biting best when he goes after those who place their faith in measurement and methodology, and who promise their students that method, not other "indefinable attributes," such as "gifts of insight, of vision, of erratic imagination," is the guarantor of truth. Noting that both Descartes and Bacon stated that students can arrive at truth simply by using the correct method, he says that "what we have here . . . is surely the highest and most unwarranted tribute that genius has ever paid to mediocrity."

He displays his own gifted insight when he explains that the next major task of the scientific-technical order will be to master the "artificial environment," which it created, just as its first major task was to master the "natural environment," which it has ruined. It is probably misleading to distinguish between "artificial" and "natural" environment in this simple-minded way, but the basic thought is useful.

Since Roszak is so hostile to the technocratic order, however, he feels that this next level of evolutionary control will simply perpetuate evil. The technocrats, having ruined the "natural world" and transformed it into a polluted and plastic environment, are up to their old tricks and now want license to clean up the pollution and rehabilitate the land they ruined. Roszak warns us not to be fooled by this, although he admits that most people will continue to be beguiled by the impressive rewards that the established order can dish out. We can interpret Roszak as warning us that "technology and science are the opiate of the masses."

It is not surprising, then, that Roszak proclaims "religious" experience to be the liberator of the human spirit. Indeed, the second role that Roszak assumes is that of prophet and advocate. He seeks not only to turn people from the old but also to tell them of the great new universe of thought and action awaiting them if they but leap out on faith and seek this liberating, religiouslike inspiration and experience. He implies that through this people will experience real reality, not the counterfeit world created by technocracy. Somehow in this new life, humans will live in harmony with nature and with their fellows.

Roszak suggests that humans did live in such harmony in the primitive and preindustrial societies of the world. He explains that in the new utopia to come, humans will be free in their minds to dream great dreams, imagine great things, spin out creatively. Again, he indicates that humans once did do this, but that the Western scientific paradigm destroyed the capacity. He feels that this capacity will again be unleashed if we can return to the "old gnosis," or religious insight and experience.

Roszak's proposition requires careful consideration. Certainly it is true that the Western scientific paradigm does "close out" certain avenues of thought and action. All cultural systems narrow possibilities in some dimensions, even as they expand possibilities in others. Certainly, small-minded men can find support for their narrow vision in the characteristic use of formal methodology, or they can hide their ignorance in the dictum that "if you can't count it, it doesn't exist."

But Roszak might just as well

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praise the humanitarian aspects of the scientific method in that it permits such ordinary persons a considerable measure of success and confidence. To be sure, their success could be at the expense of the more insightful persons who would otherwise easily gallop to startling new ideas (some of which would advance the very technocracy Roszak dislikes).

But the "scientific community" is not the monolithic thing Roszak makes it out to be. It has within it many a free spirit and certainly much debate over the issue of methodology and experiential understanding. Just as some "scientists" pursue what appears to be a more rigorous, quantitative approach, others will spin off more impressionistically, intuitively. And in some cases, both types of individuals will find ways to work together creatively in the "teams" that Roszak apparently dislikes. Probably most creative persons will break free from the constraints their less imaginative colleagues seek to impose.

Roszak also seems to have a rather romantic concept about the nature of "non-Western" and "preindustrial" societies. Can he not imagine how such societies also in many ways narrowed the vision and capabilities of their members, even as they opened them in yet other fashion? Belief in spirit forces may indeed give people a vast supernatural domain in which to meander, but these same beliefs may tell those who share them not to explore the nighttime sky or the dark forest or the deadly ocean. Such beliefs may give them a wonderfully exciting explanation of what they see in the world about them, but may make impossible yet other explanations—including those that have the potential of opening up even broader horizons.

Equipped with the concepts of biology, look at what a questing child can learn and see as he explores the environment about him—even the "man-made" environment. Or consider what wondrous worlds open to those who explore with microscope or other tools of our technology. And, although some social science concepts narrow vision, others broaden it and help people under-

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stand the lifeways of their fellow humans. Even tourism, which Roszak maligns, can provide enriching cross-cultural and cross-environmental experience and understanding, especially if the traveler is guided by some of the tools and concepts of science.

Roszak, like Lynn White, whom he quotes, persists in the belief that non-Western and preindustrial peoples characteristically have an ethic of environmental preservation. Both suggest that the West could be much improved if it only had a similar ethic. If they based their bit of wishful thinking on cross-cultural study, they might find many examples in which non-Western people also treated the environment as something to conquer, but were simply limited in their ability to conquer by their technology or their numbers. Consider, for example, how the classical Chinese reworked their environment. If a Chinese emperor could not mobilize humanpower to build dams and keep the floods back, his people felt that he was losing his "mandate of heaven" and hence his authority.

Accurate or not, Roszak is very persuasive in his evangelical and prophetic roles. Tellingly, he warns people that their lifeway is bad, that they sin by persisting in it. Then he suggests that wonders of new experience will open up to those who follow in the new path, while those who do not will labor along not knowing what they are missing. It might be logical to conclude that the third role he will assume will be that of architect of the new order, and that he will prescribe as well as describe its form, its function, and the strategies that will bring it to life. And in part this is what he does. But he does it so cautiously that other reviewers have complained that he really leaves the reader hanging up in the air, unsure about how the new and better lifeway can be achieved.

Roszak might like to be more definite, but one of the ideological underpinnings of the counterculture and alternatives movement is that the future should be achieved through the multiple and unfettered strivings of many people, not handed down by one leader. Furthermore, it appears that the

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reality of change approximates this premise. Countless social mutations burst into life throughout the United States and, through the pressures of selective adaptation, move toward a new model. Roszak sees this and mentions that "we can see the postindustrial alternative emerging in a thousand fragile experiments throughout America and Western Europe. . . ." The new society is "piecing itself inventively together within the interstices of the old." He wants the postindustrial order to be changed in this way, not by some centralized and master-planned revolutionary arm or invading force.

All well and good, and one is apt to look at his critics and say that they should not expect him to lay it all out for them. But then, just at the end, almost as an afterthought, he summarizes the character of all of these "fragile experiments" in a way that is grossly oversimplified. He declares that nearly all "blend into the tradition of anarchist socialism." He prejudges their character by putting a label on them—one that represents a pre-existing social-cultural model and that implies boundaries to their behavior and potential that others might find all too limiting. But then, he is an evangelist, whose powerful message, so wonderfully woven and elegantly written, will be widely read and debated both by foes and followers.

Luther P. Gerlach is professor of anthropology at the University of Minnesota. His most recent book, Lifeway Leap: The Dynamics of Change in America, *will be released in February.*

THE BIG THICKET, by A.Y. Gunter. *Jenkins Publishing Co. and The Chatham Press, $12.50; 172 pp., illus.*

It has often been said that individual initiative—thoughtless, prompted by profit motive, and channeled into unbridled corporate enterprise—is what is wrecking our country today. True. But it is equally true, more so now than ever, that if what remains decent and humane in us is to be rallied for the common cause, we will need to rely increasingly on the efforts of individuals who can set the pace and lead the way as they act alone. Worthy causes, more often than not, are defined and initially fostered by individuals, not institutions.

Dr. A.Y. Gunter is such an individual. An articulate, knowledgeable, and dispassionate author, he is precisely the kind of spokesman that the conservation movement needs. His cause: the Big Thicket area of Texas, a sprawling wilderness north of Beaumont and Houston, which is being ruthlessly depredated by lumbering industries and is in desperate need of preservation. Gunter's book is the best chronicle ever set forth about this fascinating region.

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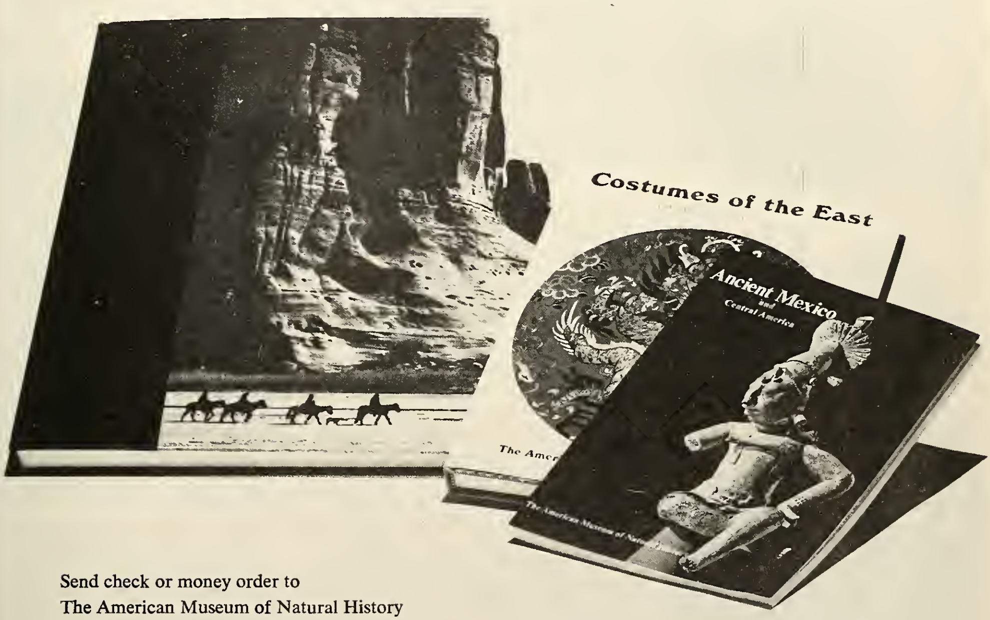
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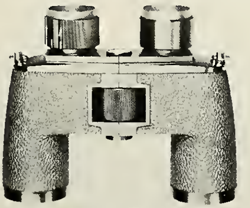

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Aside from the established fact that long-range reliance on monoculture is ecological folly (Gunter makes this point nicely), it seems downright absurd that the fate of one of America's last remaining biological wonders should rest in the hands of a few corporation executives who are neither biologically enlightened nor concerned, and who direct their operations from New York, Chicago, Toledo, and seemingly anywhere but the thicket. Interestingly, the one lumbering company that appears to have shown some consistent ecological respect in its cutting practices is Temple Industries, a firm based in Texas.

But there appears to be some hope for the thicket these days. Thanks largely to the political efforts of former Senator Yarborough and of Congressman Eckhart of Texas, a national park may be in the making that, hopefully, will save a significant chunk of the thicket. Congressional hearings were held in Beaumont this past June, and it is now generally conceded by lumbermen, politicians, and conservationists alike that there will be a Big Thicket Park. But whether it will encompass sufficient acreage of what is ecologically most valuable in the area, or merely what little the lumbermen are willing to do without, is the big question.

It is essentially to this question and to the prospects for a favorable solution that the book directs itself. By describing the biology, history, and politics of the region, and the conflicts, past and present, between the lumbermen in power and those less powerful who confront them, Gunter brings us to a closer appreciation of a complex issue that is, as the subtitle of the book properly underscores, "a challenge for conservation." A fair amount has been written about the thicket over the years, all of it interesting and much of it good. But Gunter's account, aside from its appropriate timing, is clearly the most compelling and literate. One can only hope it will have the political impact so urgently needed if the thicket is to be saved.

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man's mindless encroachment upon nature will like the book and will be enlightened (and depressed) by it. Roy Hamric's black-and-white photographs are beautiful and add a mournful touch to an already haunting and moving narrative. The book, unfortunately, is too expensive to be bought and kept. I suggest that you buy it and read it, then pass it on to your local library for conspicuous display. And do ask your senators and congressmen to back a Big Thicket park of appropriate size. The consensus among scientists who recently petitioned the government—almost 1,000 of them, including some of the most prominent biologists in the country—is that at least 200,000 acres will have to be set aside if the preserve is to survive in the long run. Lumbermen speak of possibly relinquishing 35,000 acres, and legislators appear willing to compromise at 100,000 acres or even less. This is the last chance for the Big Thicket. Unless it is saved now, there will be nothing left worth saving.

THOMAS EISNER
Cornell University

THE FOXFIRE BOOK, edited by Eliot Wigginton. *Doubleday & Company, $8.95 ($3.95 paper); 385 pp., illus.*

This book's elaborate subtitle, *Hog Dressing, Log Cabin Building, Mountain Crafts and Foods, Planting by the Signs, Snake Lore, Hunting Tales, Faith Healing, Moonshining, and Other Affairs of Plain Living*, outlines its content and hints at its drift, but it is neither the book's topic nor its tone that makes it unique or brings our attention to it.

The book is made up mostly of light, disconnected accounts of the way living is carried through by the aged and poor at the southern tail of the Appalachian region. These accounts are generally framed in how-to-do-it fashion, interrupted by constant assurances that doing it is not difficult. In this respect the book brings to mind much of the copy that filled the fine little magazine *Mountain Life and Work* for years before *Foxfire*'s editor was born.

It comes, then, as a handy guide for the person who would like to play—like Versailles' little queen played at being a milkmaid—at being a mountaineer. But the person following the directions for constructing a log cabin or butchering a hog would finish with a built-up cabin or a chopped-up hog only hazily reminiscent of the product that would be achieved by a carrier of the Blue Ridge culture.

A decade ago our reader, more interested in music than in handicrafts, would have bought Pete Seeger's banjo book. After absorbing it and endlessly repeating the right-hand patterns, he would have taken himself to Washington Square to bang out melodies in a manner far removed from that of the gentle old men who taught Pete; men in modest cement-block and linoleum homes along the Appalachian rivers who still send skylarks in silver off the necks of their instruments.

By assuring us that we can do it too, Mr. Wigginton undermines his philosophic intent: saying that mountain ways are simple sets them crudely on an evolutionary plane below our own. It is, in fact, no easier to be a mountaineer than it is to be an astronaut or a college professor, and it would take a book twice the bulk of *The Foxfire Book* to explain adequately any of the traditions that have been isolated here for presentation. As we are constantly and convincingly reminded by linguists and anthropologists, a culture's logic is wonderfully complicated, too variegated and intertwined to treat in descriptive snippets.

The complexity of the mountain people's transactions with natural givens is shadowed throughout the volume in reports of recorded traditions. In these strings of information—lists of superstitions, sketches of craft processes—it is occasionally difficult to sort out sources, to determine whether the spokesman is the editor, his students, his "contacts," the authors of uncited books, or park rangers

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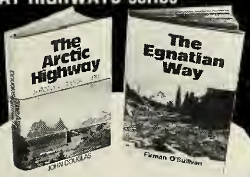

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notorious for whimsy. Although the lists are regularly animated by apostrophe-wracked transcriptions of dialect, there is none of the over-all design we have come to request humbly of ethnographers and other professional writers of travel literature.

When it is not instructing us how to carry on like mountaineers, the book is exactly like the works that were flung out during the early years of folklore as a discipline or like any of the many books written about the old ways of mountain folk during the past century and a quarter.

The third of the book's modes is the character sketch, built mainly out of quotation and straightforward description. In these, there is an unknowing revival of the genre of reportage that characterized the WPA writers projects, although the intensity and latent political thrust of the thirties is absent.

The book, rich in photographs, looks different from some that have preceded it, but it is neither better nor worse than the others in a long shelf of books on southern Appalachian existence. Those who pleasure in cataloging folk beliefs and stories will find many here to work on. Those who enjoy reading friendly descriptions of mountain folk life will like it too, but it is unfortunate that there is no bibliography to lead such a reader to the many similar works.

What, then, does the book show? That another generation has stumbled over the insight that struck Rousseau, that progress is not all good, and that an alternative to its destructive energies may be found in the wisdom of poor people who, by choice or fortune, have been left behind in the rush to improvement and doom. Indians provide the usual model for the contemporary romantic, but a decade ago it was the self-sufficient, musical mountaineer, and he may be in for a revival.

It is not the work's none-too-deep ethnography or its unformulated romanticism that makes it special; its own history is what sets it apart. Its editor's collegiate sensibilities led, not to a beard and a commune, but to a Victorian elitist's dedication. This modest American Ruskin went up to the mountains to teach and came down with a homegrown publication. He guided his students back to their grandparents and on to the production of a rich and enjoyable magazine, *Foxfire.*

For decades, students in Europe and America—especially in the Upland South—have been utilized as collectors of folklore, but this is the first time they have been given so much rein. They have learned to write clear, short pieces; but more important, by far, for a small group of teenagers Mr. Wigginton has helped to diminish the special brand of alienation currently called the generation gap. I would hope that the work of his students will mature past affection into the kind of seriousness with which James Agee went into Alabama or Claude Lévi-Strauss came away from the Amazon. The future, perhaps, will find the students seeing the old people not merely as sources of information or as warm and lovable personalities, but as human beings with complex intellects whose very existence articulates a harsh critique of the pattern into which the students themselves are snuggling.

It is the pedagogic actuality of *The Foxfire Book* and the social potential it suggests that demand that we give it our close attention.

HENRY GLASSIE
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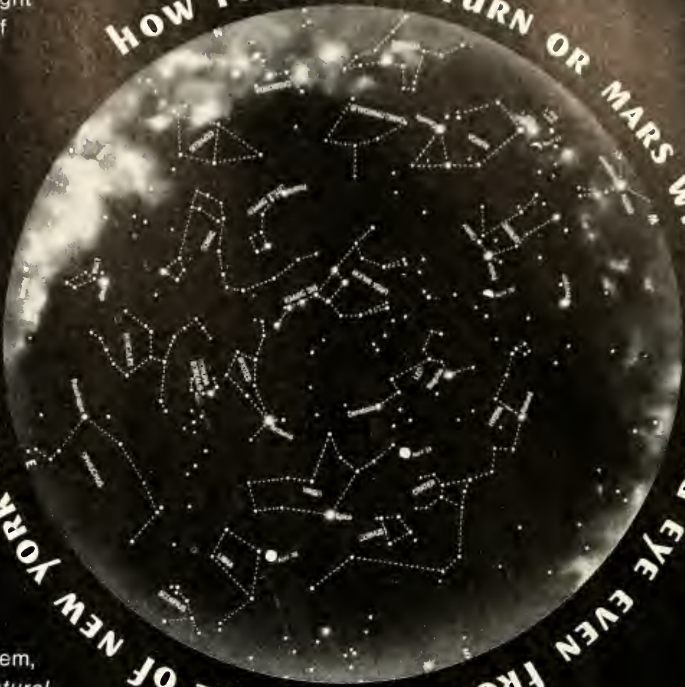

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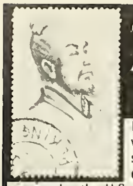

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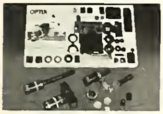

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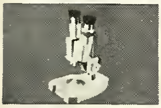

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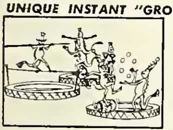

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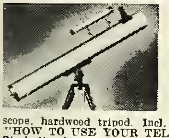

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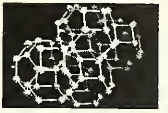

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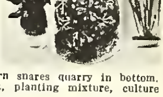

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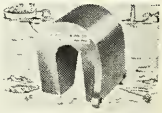

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Incorporating Nature Magazine
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Authors

Ten years ago, **Bernard L. Strehler** was pessimistic about the possibility of substantially extending the healthy middle years of people's lives. Today he feels that "this is indeed a possibility"; that "indefinite life—that is, immortality—is not beyond the edge of the possible." Strehler, who received his Ph.D. in cellular biology from Johns Hopkins University, is professor of biology at the University of Southern California and author of *Time, Cells and Aging*, Academic Press, 1962.

Bernard L. Strehler

Free-lance conservationist **Ian J. Strange** made his first visit to the Falkland Islands fourteen years ago and has since studied, photographed, and painted much of the wildlife on that small cluster of islands in the South Atlantic. Born in Peterborough, England, Strange holds a British qualification certificate in agriculture, botany, and horticulture, and is a wildlife and conservation adviser to the Falkland Islands government. He has written many conservation articles for various British publications and has just completed a book, *The Falkland Islands*, Stackpole Books, Harrisburg, 1972.

Ian J. Strange

Dena Justin's "avid interest" in archeology and prehistory complements her teaching and research as assistant professor of classics at Iona College in New Rochelle, New York. Born in Nikolaev, Russia, she has studied literature and classics at New York University and at Columbia University, where she obtained an M.A. degree in 1966. She is currently at work on a book that will project a new theory for the unsolved mystery of the Roman poet Ovid's exile to Tomis, on the Black Sea, by the Emperor Augustus in A.D. 8.

Dena Justin

Harvey A. Ardman has long been a collector of historical memorabilia and ephemera, especially items made between the years 1850 and 1930. He first became interested in Jumbo after seeing the *Book of Jumbo*, which P. T. Barnum issued in 1882 to publicize the huge elephant—a major attraction of the recently merged Barnum and Bailey circus. Ardman, who holds a master of science degree from Columbia University's School of Journalism, was formerly Science and Technology Editor for the Research Institute of America and is

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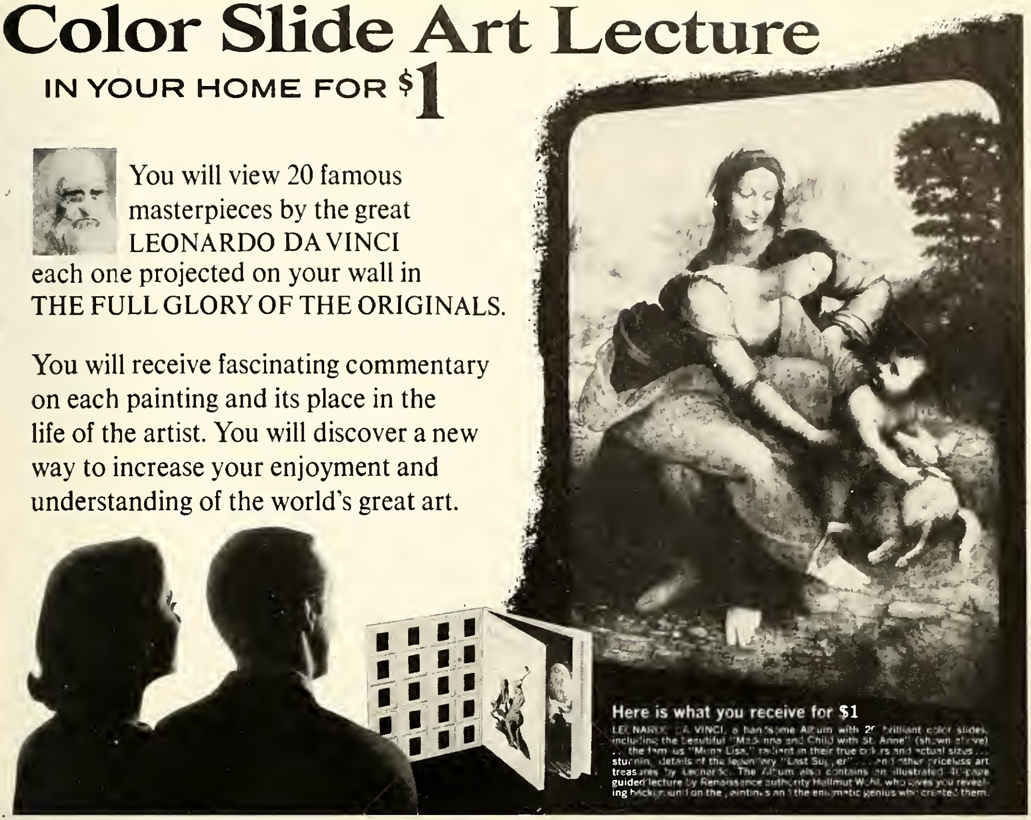

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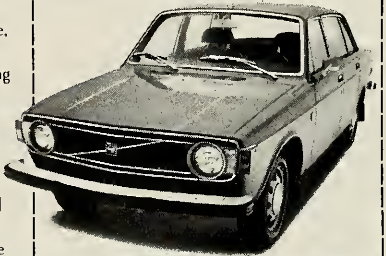

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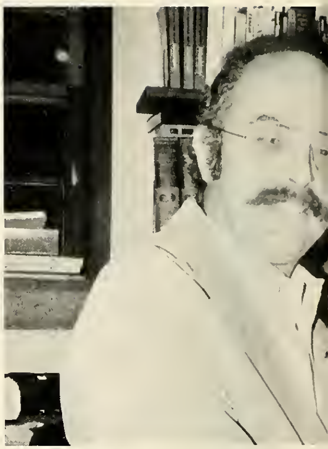

Harvey A. Ardman

presently working on a number of film scripts, including one based on the life of Jumbo.

Keith S. Thomson is associate professor of biology at Yale University and associate curator at the Peabody Museum of Natural History in New Haven, Connecticut. Born in Derbyshire, England, Thomson completed his doctorate in biology at Harvard University in 1963. In studying the evolutionary transition between fish and tetrapod, Thomson has collected fossil vertebrates in northern Kenya and Australia. In 1969 he participated in the Royal Society's experimental deep-slope fishing expedition in the Indian Ocean. Thomson, who organized the American contribution in

Keith S. Thomson

the 1972 three-nation coelacanth expedition (United States, France, and the United Kingdom) is now investigating the possibility of a deep-submersible survey and study of coelacanths in the Comoros.

John A.L. Cooke

Author of more than fifty papers on spiders, and coauthor of the *Oxford Book of Invertebrates,* John A. L. Cooke holds a doctorate in zoology from Oxford. Cooke, an associate curator in the Department of Entomology of The American Museum of Natural History, has been on arachnological expeditions to Turkish Kurdistan, Tanzania, North Africa, Jamaica, Mexico, and Trinidad. He is now studying the roles of the defensive urticating hairs of tarantulas.

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Letters

Two China Opinions

Re: "Peking Man (and Woman) Today" in your November issue. Between that and the previous installment, all I can say is that Dr. Galston apparently left his critical faculties at home when he made *that* trip.

Charles H. Chandler
Gaithersburg, Maryland

I am most pleased to have read the articles by Arthur W. Galston on his experiences in China. I certainly hope that he will continue to contribute to *Natural History* so those of us less fortunate and unable to personally experience life in China can vicariously experience through his words and descriptions. He writes beautifully and vividly projects and describes his trials, tribulations, and experiences with human beings representing a culture quite different from ours. A most worthy paper; thanks for presenting him.

Leon J. Pinsker, D.D.S.
Mill Valley, California

Quebec's Wolves

In your "Letters" of December, 1972, there appeared a most unjust and unfair opinion signed by Katherine Raynor. In her letter she tells your readers that "the Government of Quebec has launched a new extermination program for wolves, which includes hunting, traps, and poison bait." For her guidance and that of your readers, here is the official answer of the Government of Quebec to the public statements recently made on this subject:

"Following a recent wave of protests coming from various conservation groups in North America, the Quebec Fish and Game Department wishes to clarify its policy on predator control. . . . A very limited trapping program has been planned to reduce the wolf population in ten or fifteen white-tailed deer yards within a larger area of about 5,000 square miles. Deer have been suffering severe predator damage in these specific areas last year and the previous year. Special efforts are now being made to help this deer population to recover, not only by local predator control, but also by curtailing the hunting season and manipulating the winter habitat.

"The use of poison is not being considered. The control areas are determined by trained biologists and the trapping performed by experienced game wardens. The wolf range covers more than 500,000 square miles in Quebec, which means that the present control applies to much less than 1 percent of this area. This is far from an extermination program.

"When compared with most of the Canadian provinces and American states, Quebec has a very progressive predator control policy; it has no bounty on predators, it does not plan to use chemical toxicants, and it controls its predators on a local and temporary basis where the need has been certified by trained biologists. Endangered species are completely protected by law but the timber wolf or coyote cannot seriously be considered as endangered in Canada."

Guy Poliquin
Delegate General of Quebec
New York, New York

Double-Edged Hatchet

I feel I must take exception to the "hatchet job" done on author Peter Matthiessen and photographer Eliot Porter by Eliot Elisofon in "Books in Review," December.

Mr. Elisofon appears to lack the sensitivity necessary to appreciate Matthiessen's "well-tempered" prose. This leads to such blunders as asking, "What does that mean?" when presented with the author's description of the mbira as an instrument "that produces soft swift wistful rhythms of time passing." As has been pointed out by e.e. cummings and others, "Art doesn't have to mean."

Elisofon's irritating tendency to criticize for what people didn't do reaches its peak in his harping on subjects that he feels are worthy of Mr. Porter's attention. This gives him a chance to rhapsodize about what a fine fellow he is and how he would shoot thus and so. Frankly, if he were all that good, chances are Porter would be reviewing a book by Elisofon!

J. M. Dyer
York College
York, Pennsylvania

Nacirema Decoded

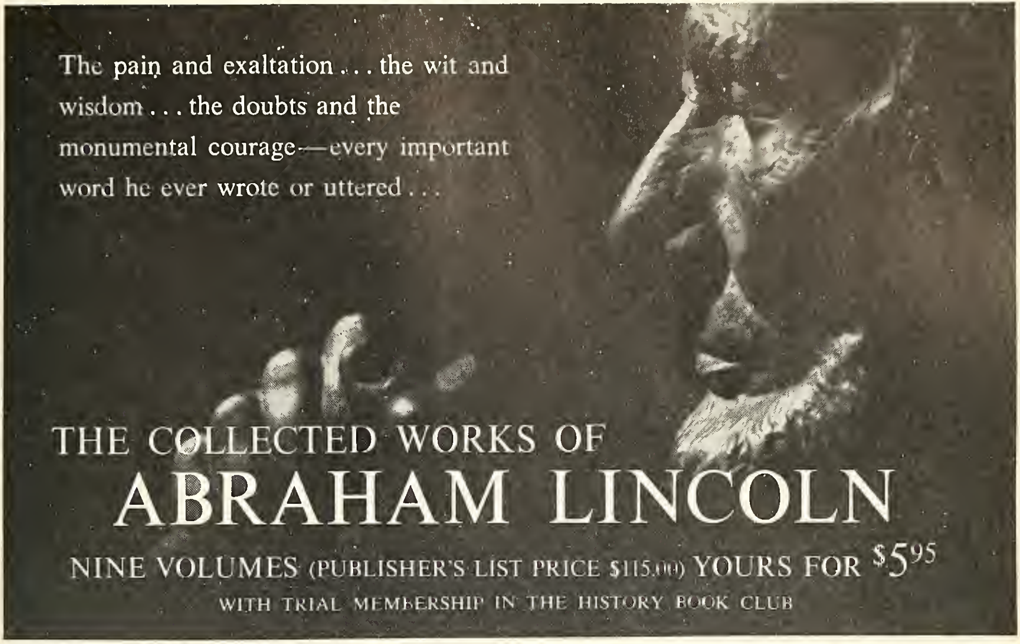
I read with considerable tseretni about "The Mysterious Fall of Nacirema" [December, 1972]. I was able to rehpiced all but one of the lausunu terms because these were spelled drawkcab.

The only unusual word I couldn't decipher was "mcnahulesque," which appeared in the tenth line on page 81. Spelled backward, it would read "euqseluhancm," which is quite wen to me, so apparently a different yek is indicated. Would you please etalsnart this one word for me into hsilgne?

J. E. Worden
Washington, D.C.

Rotide's note: The translation is "McLuhanesque."

Life mask taken 60 days before Lincoln's death. The hand was cast in 1860. From the collection of Clarence Hay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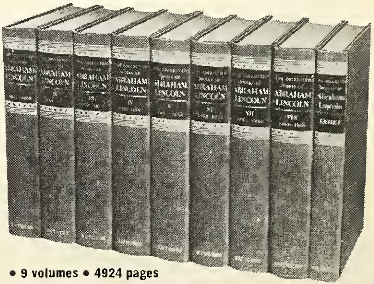

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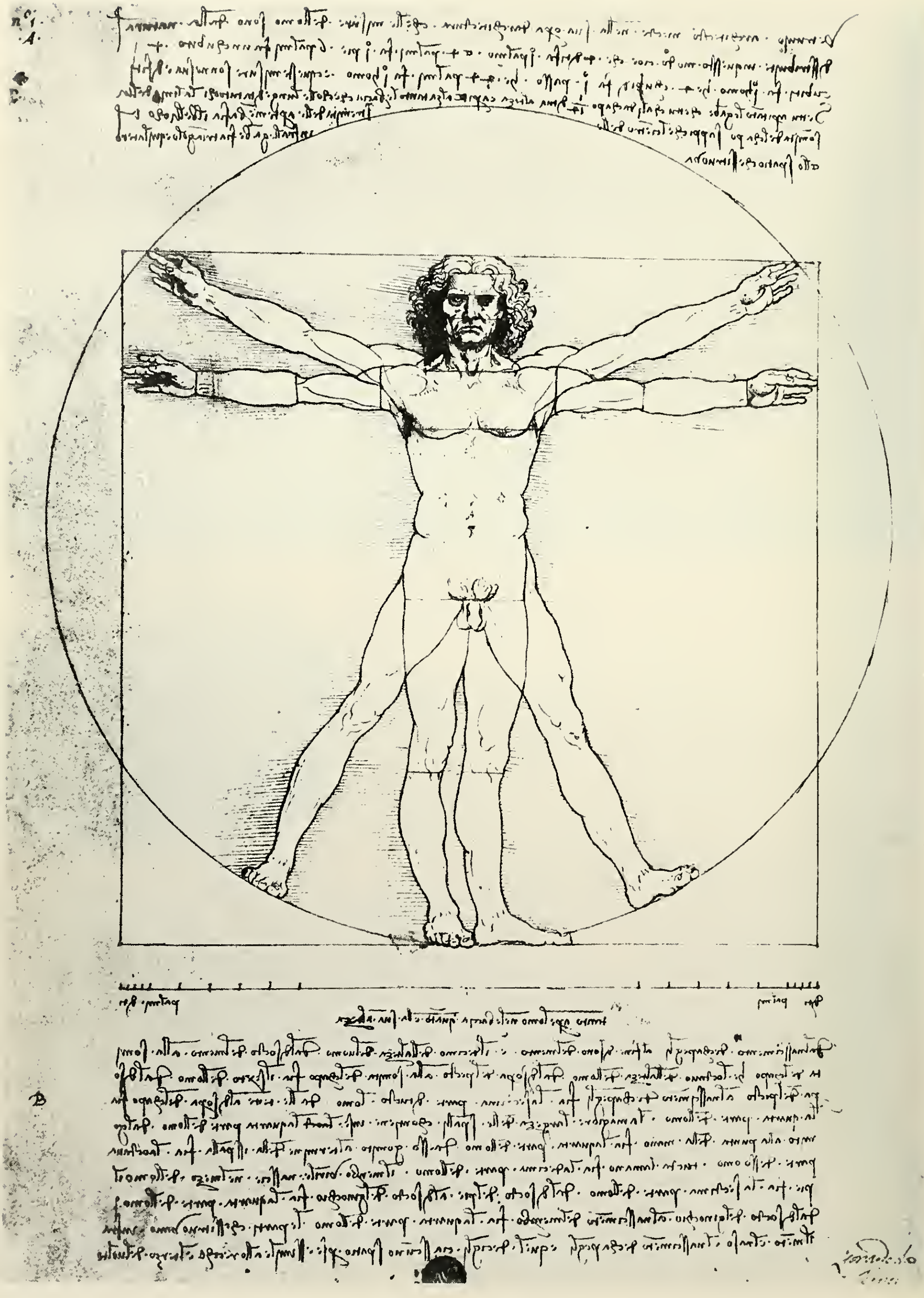


A New Age for Aging

After 30, everyone begins a steady, predictable decline toward death. Now we are on the brink of an alternative

by Bernard L. Strehler

Growing old is a process that few people care to ponder; indeed, most people skirt the issue by spending a surprising amount of time and effort trying to remain youthful. We greet long-lost friends with comments about how well they look (meaning: you haven't aged much). We automatically categorize people according to whether they are younger or older than we are (meaning: I envy your youthful vigor and appearance or you have deteriorated more than I have). Billions of dollars are spent every year on cosmetics (meaning: we want to *look* young). Men dutifully jog around their suburban neighborhoods before leaving for the office (meaning: maybe this will slow down the deterioration of my circulatory system). We adulate youth and respect age (meaning: I would like to be young again; but there must be something good to look forward to—wisdom, perhaps). We advise friends to stop smoking (meaning: you may be shortening your life). The point is that every human being, whether he admits it or not, is at least vaguely apprehensive about the slow deterioration of his structure and functions that eventually ends in death.

Concern about aging and death is an important component of our subconscious life and may contribute more than is obvious to the increased mental disease among the middle-aged and elderly. Anxiety about the changed role in life that follows the female menopause or vague fears about potency in aging males are stresses that nearly everyone endures in silence despite the reassuring witticism of gerontologist Alex Comfort: "People give up sex for the same reasons they give up bicycling—it looks silly, arthritis makes it painful, or one has no bicycle!"

With all of the deep and hidden concerns about the processes that cause this sense of impermanence, it seems surprising that society has not invested more in trying to understand, control, arrest, or even reverse the underlying causes of aging. On the face of it, nothing would seem more appealing as a goal for the average person than an extension of the healthful years of life. Certainly most men are more curious about the reasons behind their own ephemeral existence on this globe than about the constitution of the rocks on the moon or whether life is present on Mars. But to date, less has been spent on the entire spectrum of research efforts in biological aging than on a single moon shot.

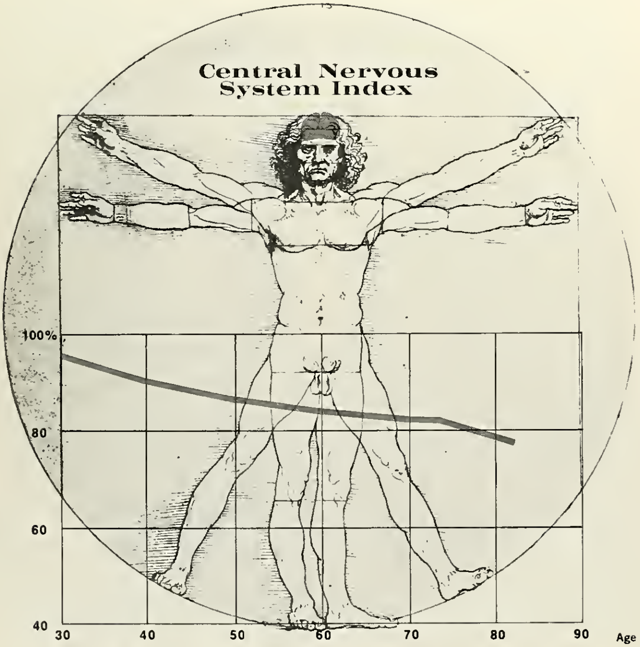
The reason, of course, is that men have become so accustomed to believing that their individual lives are finite, and that death is the inevitable price we pay for living, that they have refused to consider a biological alternative to individual extinction. After all, if death is inevitable—and unpleasant as well—why waste time, thought, and resources on a hopeless and depressing pursuit? Maybe if we don't think about it, it will go away.

Ironically, the same generation that learned to split and harness the atom, cracked the genetic code, and sent men to the moon may be the very one that will *not* benefit from the eventual amelioration of the aging process - a possibility that could become a practical reality before the end of this century. The control of the atom was the product of the urgencies of war; the understanding of how we are specified in long strings of genetic "beads," which each of our cells contains, was the culmination of a century of effort to understand the modes and mechanics of inheritance and gene expression; the conquest of space was prompted by the preceding successes of our competitors' Sputniks. But until now, the conquest of time itself has not been a social objective, and the President's recent pocket veto of a bill to establish a National Institute for Research on Aging may postpone effective pursuit of this goal for another decade.

Implicit in the drive for federal support of research in this area is the possibility that men will be able to control—and perhaps reverse—part or all of the aging process. But the only way we can accurately predict what the chances are is to understand the nature of the events that lead to human aging. The transformation of life from a young state to an old one encompasses more than the mere passage of time, but the biological processes involved are not generally understood by the public. Perhaps if the basic principles and the rapidly growing body of new data were more openly discussed, there would be greater public support for the needed investment in fundamental research. Only such research, now or in the very near future, may make greatly extended lifetimes available for present generations of humans.

There are two generalizations to keep in mind about the events that occur as we age. The first is that many, although not all, bodily functions decrease gradually as aging takes place. This will not be news to anyone: all schoolboys know they can outrun their grandfathers and that the aged are less active, usually less alert, and more subject to disease than young adults. But this knowledge had not been put on a quantitative basis. During the last thirty years, however, Nathan Shock, the father of American gerontology, and his associates have described the exact rate at which different kinds of bodily functions fail. The essence of these findings is that most functions decrease gradually, at a rate of about 1 percent of the original capacity per year after age thirty. This means that the reserve ability to do all kinds of work will run out at about age 120. It is not surprising, therefore, that about 118 years is the greatest age attained by any human for whom good records of birth and death are available. There are occasional claims that individuals in certain parts of the Caucasus Mountains of the Soviet Union attain ages twenty or more years greater than this, but in the absence of records most such claims can probably be dismissed as folk fables. Once one attains great age, there is a great temptation to exaggerate it.

The second generalization is that the chance of dying does not increase in proportion to the amount of function lost. This was discovered and formulated into a simple mathematical law in about 1832 by an English insurance actuary, Benjamin Gompertz. The Gompertz law states that the chance of dying doubles about every eight years, irrespective of the environment in which one lives. This means that the chance of dying is about 1,000 times greater for a man of 100 than for a man of 25. If we did not age—that is, if we kept the physiology of a 15-year-old indefinitely—the average human life-span would be in excess of 20,000 years. This would mean that the oldest members among us could tell stories about the last Ice Age and give personal accounts of the entire span of recorded human history.



Based on distance a nerve impulse travels in one second.

The basic question, of course, is not do we age, but what is the underlying mechanism. This can be summarized as follows: we age primarily because the cells in our bodies that cannot replace themselves either die or lose a small part of their function every year. This law applies to most of the tissues of the body, although some cells and tissues seem immune to the effects of the passage of time. These nonaging tissues include those covering the surfaces of the body (the skin and the lining of the digestive system) and the circulating cells in our blood. The skin forms a new layer of cells every four days or so, the lining of the gut is replenished every day or two, and the red blood cells are replaced on a regular schedule every four months.

Other body cells, such as those of the liver, replace themselves more slowly, although the liver (of experimental animals) can regrow to its original size within a week or so if part of it is removed surgically. Parts of the kidneys and the connective tissues are able to replace themselves more or less on demand.

Key organs and tissues in which cell replacement is either absent or inadequate are the muscles, heart, brain, and certain endocrine and immunity-conferring tissues. The nonreplenishing, or postmitotic, cells involved exhibit two major dif-

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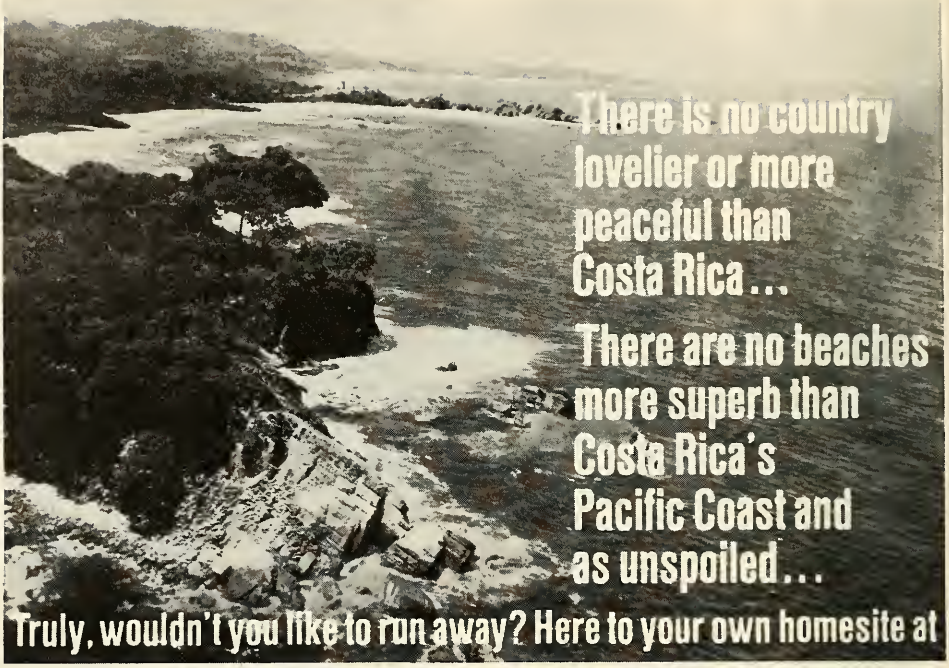

BEACHES of NOSARA

Truly, wouldn't you like to run away here to this garden of ours? Doesn't your bruised spirit need the soft touch of loving people, your tense body the pure spray of clean, clean air filtered by sunshine? Don't you long for a place where every day is gentle summer, where tree-wrapped mountains stretch 12,500 feet to the sky, where tumbling streams and waterfalls and wave-lapped beaches beg to heal you?

In all truth, isn't it a sort of self-destruction to accept without demur (as maybe you do) the dank cheerless clutch of winter cold—the wintry faces of cheerless people?

So we ask you again: wouldn't you like to run away here to a place of your own in this nature-blessed country, inhabited by a people who deserve every bit of the beauty they've been given?

For the astonishing fact is that the Costa Rican people—perhaps like none other on earth—live in peace. All of them, each with the other, live and work in *PEACE!*

Consider them, the 1¾ million of them: handsome, gentle, literate, industrious and (phenomenon of our times!) kindly—a European-sprung people who are constantly embracing, shaking hands, even with strangers, a people to whom law and order is symbolized by a smiling policeman armed with nothing more menacing than a whistle, directing traffic with a murmured "por favor." The phrase "law and order" doesn't have an ominous meaning here. It's incredible for a foreigner to learn that there is no army in Costa Rica (without an army, Costa Ricans say, there is no danger of a military take-over). The only military uniforms worn are by police and there are more schools in Costa Rica than there are uniforms. Not alone more *school-children* or more *school-teachers* but actually more *schools* than military uniforms! Amazing? No wonder that Gov. Nelson Rockefeller, having undergone a rather stormy Latin American tour in 1968, exclaimed happily when he finally got to *simpatico* Costa Rica: "This perfect jewel of a country!" *The NEW YORK TIMES* in an editorial on February 5th, 1970 headed "*Costa Rica's Example*" praises the solid democracy of this tiny country and says in part: *"Doing what comes naturally, a half-million voters have brought off* (Costa Rica's *fifth* successive) *peaceful presidential election in twenty years."*

Yet, it isn't only each other whom Costa Ricans like. There is no xenophobia here at all: foreigners are warmly welcomed and North Americans, especially, are cherished. Nearly 15,000 of us from the U.S. live and prosper in Costa Rica. English is widely spoken, and the word has been gradually slipping out that in this *"jewel of a country"* lies the fulfillment of the wistful dream of so many harassed Americans: the mind picture of that perfect retreat where climate and man are in gentle harmony with each other.

It's rather astonishing that this spectacularly beautiful country, really not that distant from the States, is much less familiar to Americans than the islands of the Caribbean. Almost everyone knows, and many have visited, the grouping of tropical Edens called the West Indies—their fabled greenness, the sparkling waters in which they are set. Yet Costa Rica's climate has all the balm of its island neighbors and is more exhilaratingly varied. The sea that stretches along the east coast of this slender strip of Central America is the Caribbean. Go west less than 150 miles and there is the Pacific: nowhere does this greatest of oceans wash more beautiful shores than Costa Rica's. Incongruously, some travel writers have called this country "The Switzerland of Central America"; still it is true that Costa Rica's mountains are as glorious in their tropical setting as the Alps in *their* ambience. And it is further a fact that these mountains aid in making the climate the delight it is. San Jose, the capital, is in the central plateau, 3500 feet above sea level, and about midway between the Caribbean and the Pacific. The city's climate is simply nothing less than perpetual Spring with the mean temperature steady at 70° every month of the year. But even at Pacific coast sea level — at our BEACHES OF NOSARA, for example — even here, the mean annual temperature is only 78 degrees accompanied by humidity so low that it can't be matched by the Caribbean islands. And not to put down the exotic West Indies, there's a good deal more of Costa Rica that the islands can't match. Nature thrives on an immense scale here. Naturalists have identified 762 species of birds (in *all* of the United States, 130 times Costa Rica's size, there are 725 varieties). And such birds! Partridge, parrots, cuckoos, toucans along with the wrens,

(Advertisement)

thrushes, orioles, finches. We have deer, raccoon, monkies. Costa Rica's soil is so fertile that Texas cattle ranchers are incredulous that what would be prized crop acreage in their state is used casually as cattle-raising land here. (It has been reported by the WALL STREET JOURNAL that Lyndon Johnson bought a ranch on the Pacific side of Costa Rica.) And what lush growth springs from the soil! Great forests of majestic trees; lignum vitae can be so huge that a single tree's branches may shelter an entire herd of cattle. There are groves whose boughs bend under the weight of fruit—citrus, mangoes, bananas, coconuts. Costa Rican coffee is unparalleled. Hundreds of varieties of orchids grow wild. We produce vegetables of a size and flavor such as few North American housewives have seen (our portfolio, if you'll send for it, has photos taken in a market and you'll find hard to believe those giant radishes and scallions).

Costa Rica has a record of steady economic progress and every foreigner who has come here is instantly aware that this progress is mounting toward affluence. Clearly, a country of such natural richness and with so extraordinary a people, puts fresh meaning into the overworked word *opportunity*. Oh, opportunity is here, all right. And for none better than for North Americans. There are no restrictions against private investment and the list of American businesses, small and large, is long. For you who simply want to retire, there are special privileges if you are not a Costa Rican, all you have to prove is a guaranteed income of $325 monthly for you and your wife and you are exempt from paying taxes. San Jose has everything—for the soul as well as the stomach. Opera, symphony, splendid movie houses, theater (its National Theater, marbled and mirrored, is a graceful replica of L'Opera in Paris). Many doctors and surgeons are from U.S. medical schools; the hospitals are excellent. You can buy anything in the handsome shops and the cost of living is joyfully low. T-bone steak, eggs, vegetables, fruits are far below U.S. prices. An elegant Spanish architectural 3 bedroom house can presently be constructed for less than $10,000, and a live-in maid and a gardener will service it at a combined monthly wage of $80 for both.

Education is a positive obsession in Costa Rica. There are 2,379 elementary schools with 350,000 children attending, and 112 high schools, art academies, business schools, etc. The beautiful complex of the University of Costa Rica has an enrollment of 12,000 students. And the academic standing of the English language private schools is very high. The most prestigious of these accommodates North American children at a tuition of $38 a month. And that includes busing to and from school!

San Jose has a fine airport, one of the largest, most convenient and modern in Central America, and the jet flight from Miami via LACSA or TACA takes about 2½ hours and presently costs $182 round trip. For the autoist the drive from the States along the Pan American Highway is a memorable one; south of Cartago in Costa Rica, the famous road climbs to its highest elevation—10,931 feet.

So it had to happen: Here we were, a group of Americans—land developers. We'd heard of Costa Rica and we came here, instantly to be entranced by its beauty and won by its people. We knew quite soon—almost like the original Spanish discoverers who gave it the name "*rich* coast"—that this was the country we'd been looking for. All that remained now was to find the quintessential tract of land that had everything—natural loveliness, serenity, climate, beaches. We found it. We found it in the peninsula of Nicoya directly on the Pacific. And we named this tranquil place . . . BEACHES OF NOSARA. . . .

We've employed many superlatives in this ad—maybe, you'll suspect, even extravagances. Yet at the risk of once more stretching your bounds of credibility, we say this: that nowhere in the world will you find more glorious beaches than the two miles of beautiful white sand and unimaginably clean, clear sea that front our property. There is one section that is modestly compared to the best surfing Hawaii has to offer; and, wonderfully for the less adventurous, there is a long piece where the sea is quiet and where even infants can play in the water as it rolls gently onto the sand. If you're a shell collector you'll find, day after day, specimens you've never before seen. And out from shore are the boating and the skin diving, the fishing. A world of fish, a treasure-house for you, if that's your passion: tuna, dolphin, wahoo, grouper, snapper—the whole catalog, believe it. How rare to discover that today—a pure sea teeming with healthy fish. Yes, as much as anything it was the ocean and the beaches that caused us to choose NOSARA.

But then one turns his back on the Pacific and looks out at the land and isn't that something to see—this rich-soiled, lushly-covered sculpture of hills and valleys! It is big—3300 acres—but we intend to convert only a *part* of it to homesites. We've brought in ecologists and other scientists to help us preserve the natural beauty of this place. We have laid about 35 miles of horseriding trails, all within the boundaries of our property. If a precious tree stands in the way of a bulldozer the tree stays; we bend the road around it. If it's to be a match-up between "progress" and nature we'll ride with the trees and the birds.

But of course we've brought in the machines and used them. Every site in BEACHES OF NOSARA fronts a road. Every home is guaranteed electricity and pure delicious water. We hope to build a superb golf course with 9 holes to be completed next year in 1973, and we expect to build the first of our tennis courts shortly. We've built a charming hotel with club facilities and an airfield to bring you here quickly from San Jose.

We're not new to this profession. We've been developers in the West Indies and we do appreciate those magical islands. But this is the simple truth: no island in the Caribbean can claim what we have in this ad. And when one realizes that some improved sites in the West Indies have now soared to fantastic prices—that one dollar a square foot, $10,000 for a quarter-acre is now becoming the rule, then BEACHES OF NOSARA becomes almost too good to be true. For the price of our homesites is only 40¢ a square foot, $4000 for a quarter-acre, 4% down and 2% a month, with no interest charges! And that *includes* roads, electricity, water, one year free golf membership and the unlimited use of the natural paradise that we've inherited and are preserving for you.

We're running out of space and there's so much more to tell you. Some of you may visit us after reading this message. Most cannot. For those we have prepared a thick portfolio. It includes a large color brochure, maps, house plans, and a 96 page condensation of Prof. Donald Lundberg's authoritative book "COSTA *RICA*." All this is FREE.

Our portfolio also tells you how to go about reserving a homesite in BEACHES OF NOSARA and spells out our money-back guarantees: an unconditional 60 day deposit refund warranty; and a full year after signing contract to visit the property and see for yourself whether it delights you. If not, every penny you'd have paid in is refunded without a word.

We're quite certain that we have something very special in BEACHES OF NOSARA and we already know that the response to our advertising is going to be quite lively. We sincerely urge you —if you wish to be in time for the choice lots—to fill out and mail the coupon right away. Our portfolio is free and you are under no obligation at all. Indeed, no one will ever phone you or call on you. It's only the mailman you'll see.

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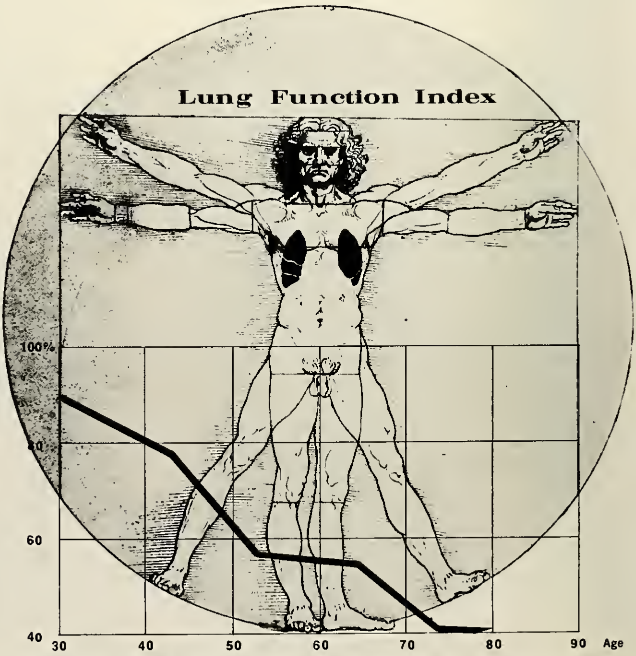
ferences from those in other parts of the body: many of the cells that remain in the tissues of an old animal are either larger or smaller than usual and the resultant irregular appearance of many old tissues is one of disorder; the second, obvious change is the accumulation of yellow-brown colorations known as age pigments. These materials accumulate slowly with age, and in the very old they may occupy nearly the entire cell body. They are believed to be produced by the reaction of oxygen with unsaturated fats in the membranes within cells. This reaction is similar to the one that causes varnish to harden and turn yellow as it dries and ages.

The rate at which it occurs can be reduced, in the test tube at least, by adding substances called antioxidants to the mixture. In this process the antioxidants trap intermediate molecules, called free radicals, and prevent such reactions from becoming self-perpetuating. Vitamin E is one antioxidant that occurs in nature, and BHT, a synthetic compound used to prevent various food products from turning rancid, has similar effects. One group of studies by Denham Harmon of the University of Nebraska indicates that it is possible to extend the lives of experimental animals by adding antioxidants to their diets. Whether the increased longevity is due to the suppression of antioxidative reactions within cells and tissues is not yet certain.

Recent studies also indicate that cells cultured artificially eventually lose their ability to divide or renew themselves. In his careful and imaginative work in this area, Leonard Hayflick of Stanford University has shown that human cells such as embryonic fibroblasts can only undergo about fifty divisions under artificial conditions. Whether such limitations occur in the body itself is not yet clearly settled. It seems likely that skin and gut cells, for example, are able to divide hundreds or thousands of times during the lifetime of a human. Some recent research suggests that all cells manufacture and accumulate materials that tend to prevent their division when the concentration of these substances is large enough. One class of such substances, called chalones, only inhibits the growth of



Based on volume of air inhaled and expelled in one minute.

the tissue from which it is extracted.

Lack of materials that inhibit cell division may contribute to the development of cancer—a disease that primarily affects the elderly. One reason that cancer develops could be that the natural inhibitors, perhaps "chalonelike" substances, are either not produced in adequate amounts or no longer have a growth-stopping effect on cells that have become malignant. This is an oversimplification of the origin of cancer, but several lines of evidence indicate that it is at least a part of the picture.

The key to understanding aging is to be found in the mechanisms that control and prevent the division of cells. Much information may fall out of the understanding of cancer, but it seems unlikely that all of the needed facts will result from the pursuit of studies directed toward other goals. What is needed is to focus an adequate research effort specifically on those processes that cause cells to lose vitality with age.

A law of nature states that all systems tend to become more disorganized as time passes unless energy is expended to generate order. Stars burn themselves out; untended gardens go to weed; social institutions become more unmanageable as they age. This also applies to the cells and molecules that make up the individual human being; unless molecules are stored at absolute zero and shielded from all kinds of radiation, they will gradually revert to less ordered arrangements of their atoms.

In one sense, living systems are an exception to this rule, for plants and animals do create order out of chaos. These living organisms are special kinds of machines, which harness the matter and energy about them in order to make more of their kind.

The basic reason that living things are mortal is that this must have favored their evolutionary success. One explanation for this paradox—the death of individuals favoring the perpetuation of the species—was suggested by Peter Medawar, a Nobel laureate in medicine and physiology, who pointed out that some kinds of successful adaptations carry with them side effects that indirectly lead to aging and death. For humans, three such

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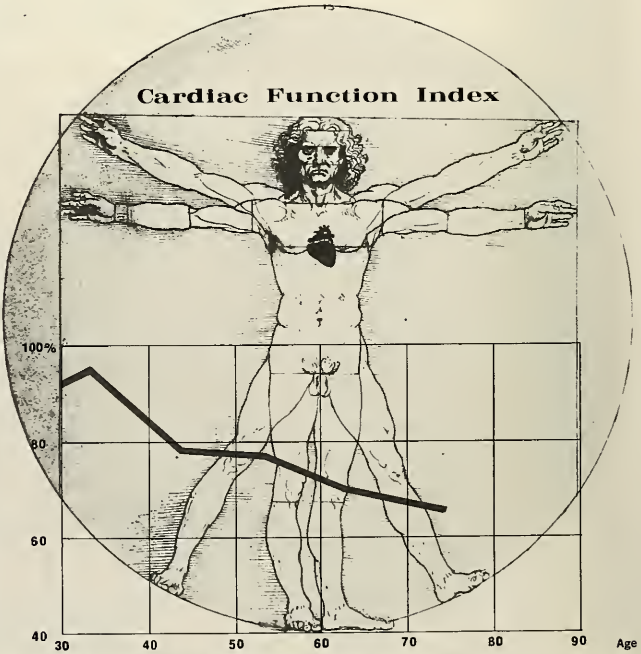
adaptations are particularly important: man is best able to function if he has a particular size; man's brain serves as an information storage device, as well as in other ways; our ancestors evolved in competitive environments, which placed a premium on the efficient use of raw materials. What unites these adaptations is that they all involve the "switching off" of certain inherited abilities at specific times in the life-cycle, and it is this process that ultimately causes the system to fail.

The limitation of the human body to a certain optimum size is achieved by the turning off of the genes that would lead to continued growth. The stabilization of memory elements in the brain is achieved, in part, by suppressing the ability of nerve cells in the brain to divide (nerve cell division is a great rarity after birth). Economy in the use of raw materials requires that only those parts that deteriorate rapidly—the skin, gut lining cells, blood cells—are regularly replaced. Tendons, muscles, heart, and brain cells stop replacing themselves as maturity is approached.

The consequence of this switching off of genes is to remove the affected cells from the "living system" category, as defined earlier, with aging and death eventually following. Yet all cells, whether in a functioning or switched-off state, contain the necessary genetic instructions to replenish themselves. When we discover how to unlock the information hidden in the DNA of each nonreplenishing cell, man may indeed possess the knowledge necessary to convert himself into an immortal.

Before the present revolution in biological thinking—the result of understanding how DNA stores the instructions to put the body's parts together—we had exceedingly cumbersome ideas about the regulation of gene expression. It had been thought that each specific event in each kind of cell was controlled by a huge set of genetic instructions. It seemed inconceivable that man could devise nondestructive means for interfering with the enormous complexity of the regulating systems involved.

But it has now been demonstrated that the genetic code is



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really very simple. It was proved that it is a sequence of just three consecutive "beads," the nucleotide bases in the DNA, which code for a given kind of building block in the working parts of cells. (The building blocks are the body's total of twenty different kinds of amino acids, and the working parts are proteins, which are simply long chains of amino acids arranged in very specific ways according to the instructions provided by the DNA.)

It also has been shown that only two different types of control locations are involved in the regulation of which kinds of genes are expressed. These sites, on the surfaces of the DNA and of the ribosomes, control the copying of the information in specific segments of DNA—a process called transcription—and the decoding of this copied information—a process called translation. In other words, cells can select which of the many products they will make by either controlling the kinds of DNA copied or the kinds of messages decoded.

The importance of these discoveries in terms of the potential control of human aging is enormous. Instead of an imponderable array of control points, the number may be quite small, perhaps only a few dozen. This implies the possibility of producing chemical agents that will selectively change the controls of switched-off cells, thus releasing the latent genetic information needed to produce replacement parts—just as it is possible to produce antibiotics that will destroy infective bacteria without materially harming the body's functions. And far from being an unattainable goal in this generation of humans, selective production of new cells and tissues through pharmacological intervention is on the verge of being tested; at least the basic technology is at hand.

Whether this optimistic view is justified will depend on the results of experiments designed to test a theory of gene regulation proposed about ten years ago. Harvey Itano, now a professor at the University of California at San Diego, suggested that certain genetic diseases are due to the inability of cells to translate some of the code words present in genetic messages. (He was interested in a blood disease, thallas-

Continued on page 82

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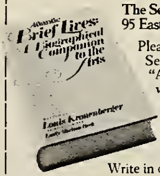

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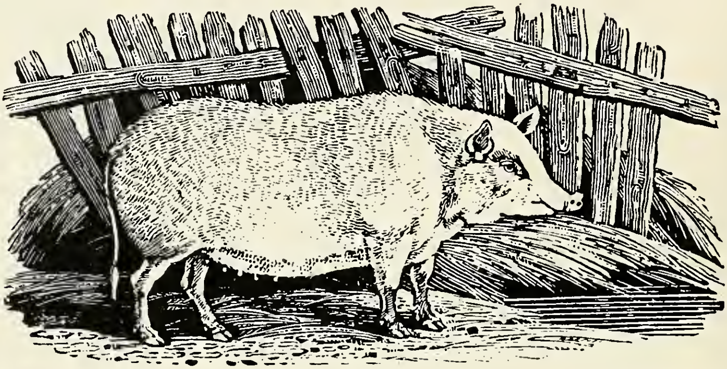
Riddle of the Pig, II



"Pronouncements about the inexplicability of human events . . . are themselves often the chief obstacle to the advance of anthropological knowledge"

A number of readers were critical of last October's column, "Riddle of the Pig" ("Hogwash," wrote one wag). I hope that the following discussion will clarify the issues and meet some of the objections that have been raised. But first, let me recapitulate what seems to be a plausible explanation of why pork was banned by the ancient Hebrews and also by the followers of Mohammed.

In the arid Middle Eastern heartlands the subsistence agriculture practiced by the semisedentary pastoralists and grain farmers was ecologically incompatible with large-scale pig production. Pigs need shade and copious amounts of external moisture when temperatures rise above 99 degrees. Some suitable small niches—river banks, swamp borders, and remnant upland forests—were available for swineherding. But the intensive exploitation of these zones for pig raising was incompatible with the system of grain farming and ruminant (goat, sheep, cattle) pastoralism. The antipork taboos may therefore be viewed as an ideological defense against the temptation to divert substantial inputs from a highly efficient farming and pastoral complex to an inefficient and marginal luxury product, valuable only for its delectable, fatty meat.

In objecting to this theory, several readers insisted that the reason for the taboo was simply that the pig is, in fact, a dirty and disgusting animal. Pierre Gringoire, for example, reminded me of "the pig's habit of eating with great relish and many delighted grunts human excrement." Another correspondent, even more graphically inclined, told of once being surrounded by pigs before he could leap back over the stone wall behind which he had chosen to squat. Other commentators pointed out that pigs will even eat carrion, "which obviously seems unclean," as Dorothy Muegel put it. Reader Paul Squibb neatly summed up these sentiments with the observation that "the Mosaic injunction was something like: 'You mustn't eat any part of your sewer system.' "

The reason I didn't mention this aspect of "piggishness" is that, among domestic animals, it is scarcely peculiar to the pig. In South American Indian groups, for example, the role of fecal and carrion scavenger was monopolized by the dog. Friends who have studied among the Eskimo tell of Rabelaisian encounters between themselves and their host's huskies whenever they had to step outside the igloo during the winter night. Dogs, of course, are eaten in many societies throughout the world. So the consumption of carrion or human feces by a domestic animal is not by itself sufficient reason for placing a ban on the consumption of its flesh.

Nothing in nature "obviously seems unclean," least of all the pig. Millions of people in Latin America, Asia, and Oceania enjoy eating pigs, even though they know the animals have consumed substantial amounts of carrion and human feces. In New Guinea and Melanesia, the pig, far from being regarded as loathsome, is thought to be the most sacred and beautiful of all nature's creations. Incidentally, the conditions for raising pigs in such places—heavy rainfall and lots of trees—are the direct opposite of those in the Middle East.

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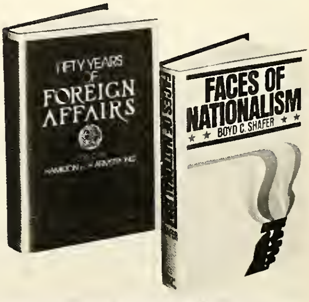

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readers that pigs in the Middle East were loathsome because they were primarily fecal scavengers leads back to the ecological factors stressed in my theory. Restriction of pigs to rations consisting primarily of human excrement obviously imposes drastic limits on the size of the pig population relative to the human population. We would need, therefore, to explain why the pig was raised in this manner, rather than by extensive swineherding or by an intensive grain supplement. In other words, we would have to explain why the pig ate more sewage in the Middle East than elsewhere. The explanation is the same as the one I gave for why the pig in the Middle East had to cool itself by wallowing in its own excreta rather than in fresh water: the pig is an ecological anomaly in the hot and arid Middle Eastern heartlands.

Another group of correspondents dismissed my ecological solution to the riddle of the pig because it failed to explain all the other food taboos mentioned in the Bible. William Alkus accused me of perpetuating the common error "that the forbidden food or those things unkosher are primarily the pig." I concede that I should have taken more care to explain why I was emphasizing the pig. I was not unaware that many other animals are banned in Leviticus and Deuteronomy. But the ban on pork has always seemed the most difficult to understand in rational and ecosystem terms. Of all the animals whose flesh is forbidden in the Five Books of Moses, the pig is the only one that is a domesticated animal bred primarily for the value of its meat. Therefore, the taboo on pork initially seems utterly baffling and entirely a result of scientifically unknowable causes.

I fail to see why I should be expected to explain all the other food taboos in the Bible as a reward for having offered a plausible solution to the riddle of the pig. Some years ago I offered an ecological explanation, which has since been largely confirmed, of the Hindu taboo on the consumption of beef (*see* "The Myth of the Sacred Cow," *Natural History*, March, 1967). "Ah!" said the skeptics. "But what about the Chinese aversion to milk?" And when I showed how that, too, could be given an ecologi-

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cal explanation, I was told, "Oh, yes. But what about the Hebrew and Moslem taboo against pork?" Unfortunately, I just don't seem able to resist these challenges, so here comes an ecological explanation for the entire set of creatures whose flesh is forbidden in the Mosaic code.

Cultural ecological theory predicts that religiously supported food taboos seldom, if ever, decrease total energetic and nutritional efficiency; actually, such taboos often constitute ideological barriers against food practices that might tend to degrade specific ecosystems or impair their bioenergetic productivity. I maintain, in conformity with this principle, that the great majority of forbidden flesh in Leviticus and Deuteronomy belongs to feral mammals, birds, reptiles, fish, and insects whose retention in the ancient Hebrew diet would not have significantly raised, and could easily have lowered, the capability of the seminomadic pastoral and farming complex to support human life.

Let us start with the interdiction against eating beasts that have "paws." The animals most likely to have been included in this ban consisted of predators, such as weasels (specifically mentioned), wildcats, foxes, and wolves, plus domestic cats and dogs. It seems unlikely that a people who raised large numbers of sheep, goats, and cattle would often want to be in a position to dine on carnivorous predators. The whole object of pastoral management is to exterminate predators or at least to keep them far away from one's herds and flocks. Dogs in such ecosystems are used primarily to herd and hunt; for meat production, anything fed to a dog would be better put into the mouth of a goat. As for cats, which were primarily house pets, they are a sorry source of protein under the best of circumstances.

Among animals specifically mentioned in Leviticus 11 we find the chameleon, lizard, and mole, and, by implication, the snake. Avoidance of such difficult to catch and/or calorically insignificant tidbits cannot conceivably constitute a nutritional loss for people who keep meat- and milk-producing ruminants—although such animals might very well constitute a net caloric

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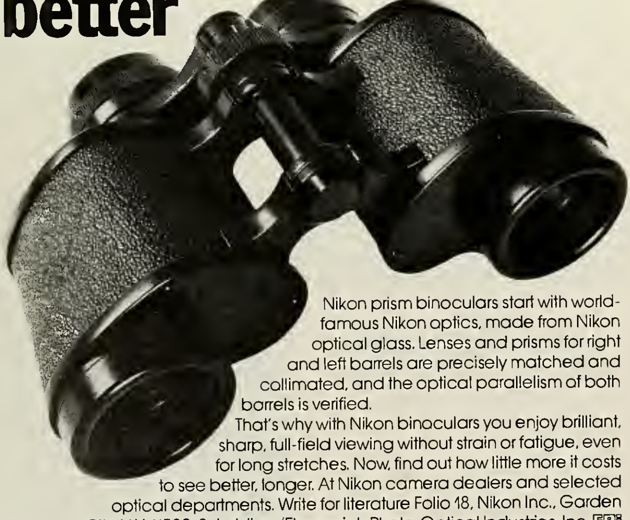

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loss if they were the object of serious culinary attention.

Another large category of forbidden creature, which is not designated by species, consists of water dwellers without fins or scales. By implication, the interdicted species are usually understood to include eels, shellfish, whales, porpoises, and several "scaleless" fish, perhaps including sturgeons, lumpsuckers, lampreys, hagfish, and catfish. It seems to me that pastoralists were well advised to forget about hunting for whales or sturgeon or collecting clams or devoting much effort to difficult to catch, difficult to eat, or relatively rare fish. Similar observations apply, I believe, to the tortoise and snail, which are mentioned specifically.

I come now to birds, the largest group of specifically identified forbidden creatures. The list is dominated by such unlikely sources of human food energy as eagles, ospreys, vultures, ravens, hawks, swans, storks, herons, and lapwings. Bats are included among the birds and exemplify the same principle of nutritional triviality.

Turning to the category "insects," we find a surprising exception to the general taboo. Four kinds of locusts are specifically recommended as good to eat. Is it an accident that locusts also happen to be nutritionally significant in the biblical heartlands? I think not. Locusts were not only abundant but they also tended to become available under circumstances that recommended they be consumed without ado; namely, when swarms had stripped the fields and locusts were the only thing left to eat.

The remaining category consists of the animals that "part not the hoof," or "chew not the cud." Although not mentioned specifically, the domesticated horse and donkey are usually thought to have been among the species implicated by that formula. I find little to ponder in the case of the horse. This animal was bred for aristocratic and military purposes. It was a great luxury, even for the royalty of Egypt and Babylonia, and could never have provided meat for more than a tiny fraction of the ancient Hebrew population. I am less confident of the status of donkeys; still, these animals were bred for portage, not for food, and I am unaware of any culture in which donkey meat is regularly on the menu.

That leaves, among domesticated species, the camel, whose flesh the Bible specifically prohibits. Several correspondents were particularly concerned about what the taboo on camel flesh did to my ecological explanation. ("Can Professor Harris dare say the camel is not adapted to the Middle East?")

Although some of the ancient Hebrews kept flocks of camels, these animals are pre-eminently creatures of the deep desert. They are associated with a fully migratory Bedouin life-style, not with the semisedentary adaptation of the ancient Hebrews. Throughout most of the Mosaic period, camel flesh was probably no more abundant than horse flesh. But the camel is an extremely important test of the ecological approach in another sense. Mohammed specifically reaffirmed the Mosaic taboo against only one animal, the pig. And he specifically rescinded the Mosaic taboo against only one animal, the camel.

This was no mere whim. Indeed, it is difficult to imagine how the subsequent history of the world could have been quite the same had Islam maintained the ban on camel flesh. The Arabian tribesmen who were Mohammed's earliest supporters were camel nomads. They depended upon the camel for their entire livelihood; camel flesh was for them an emergency ration without which they could never have ventured forth on their spectacular journeys across the desert.

I have not quite exhausted all the animals that were specifically interdicted in the Mosaic code (the taxonomic identity of several species remains unresolved). But in any case, I do not intend the preceding analysis to be anything other than a series of hypotheses that merit consideration before one finally concludes, along with several of my correspondents, that "no logical explanation of food taboos is possible." It has been my lifelong experience with pronouncements about the inexplicability of human events that such pronouncements are themselves often the chief obstacle to the advance of anthropological knowledge.

Columnist Marvin Harris teaches anthropology at Columbia University.

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A Basic Unity of Life

As biologists delve further into the mechanisms of nerve transmissions, they uncover striking similarities in the plant and animal kingdoms

Last month I discussed the probable significance of, and the basic physiological processes controlling, the sleep movements of leaves. Now I want to focus on the biochemical mechanisms involved in the leaf movements of the leguminous silk tree, *Albizzia*. The leaves of this plant are subdivided into pairs of opposing leaflets, which lie open during the day and close up tight against each other at night.

The main chemical event regulating the movement of these leaflets is the movement of potassium into and out of the motor cells of the pulvinus, the fleshy joint connecting leaf stalk and stem. The leaflets are open when the upper cells of the pulvinus are rich in potassium. The potassium richness raises the osmotic concentration of the upper cells; they thus take up water and swell, forcing the leaflet to pivot down and away from the stem. When the upper pulvinal cells lose potassium and the lower cells gain it, the opposite changes occur, and the leaflets fold together, or close. The leaflets are generally open in the light and closed in the dark, although the major control is an internal clock that seems to work by controlling the "leakiness" of the pulvinal cell membranes to potassium and other solutes.

Whether or not a leaflet closes on transfer from light to darkness depends in the first instance on the phase of the internal rhythm. Erwin Bünning suggested that the "photophile," or light-loving, half of the cycle begins when the light goes on, and that the "scotophile," or dark-loving, phase starts twelve hours later. Thus, a leaf that has been in light for, let us say, ten or eleven hours will close promptly upon being darkened, because each half of the circadian (daylong) rhythm lasts for about twelve hours. Even if left in light for more than twelve hours, such a leaf will start to close, but if transferred to darkness it will close much more rapidly and completely.

On the other hand, a leaf transferred to darkness after only one or two hours of light will not close very vigorously or completely. This is "explained" by saying that the clock that keeps time for the plant in the measurement of the daily rhythm is still in the photophile setting, and is thus not in the correct state for dark reactions such as closing. This is not really an explanation, but simply another way of saying that the rhythm can be shown to exist, and can be measured and even defined in terms of the changing ability of leaflets to fold together in darkness after having received varying periods of light. The 24-hour rhythm of terrestrial plants has presumably evolved in response to the earth's 24-hour day. Thus, if plants are ever discovered on other planets with different day lengths, they could be expected to have differently timed rhythms if they have rhythms at all.

All plants possess small quantities of phytochrome, a remarkable pigment that is very sensitive to light. When a plant is stored in darkness for several hours, the bulk, if not all, of its phytochrome is in a form that absorbs red light strongly. Upon irradiation with ordinary sunlight or any sort of mixed wavelength "white" light, the pigment is transformed to another molecular configuration, which no longer absorbs heavily in the red region of the spectrum, but rather in what we call "far-red," or just barely visible longer wavelength light. During daylight, which contains more energy in the red than in the far-red part of the spectrum, phytochrome is kept predominantly in the far-red absorbing form. In darkness, this form spontaneously reverts back to the red-absorbing form. For convenience, the red- and far-red-absorbing forms of phytochrome are called P_r and P_{fr}. The transformation of P_r to P_{fr} by light—and the subsequent reversion of P_{fr} to P_r in the dark—seemed to provide an obvious chemical "hourglass" mechanism that could furnish a basis for the alternating photophile and scotophile phases of a plant's behavior. Further investigations have shown that the timing mechanism is, in fact, much more complex.

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two-way switch for turning off and on any process it controls. If conversion of phytochrome from the P_r to the P_{fr} form is responsible for the opening of the leaflets as they are moved from dark to light, then red light should cause opening and far-red light given immediately after the red light should prevent it from acting. Although the state of phytochrome is not the primary regulator of leaflet *opening*, it does closely regulate the *closure* of leaflets when they are transferred from light to dark.

This relationship can be shown by the following simple experiment. If after the initial, natural light period (phytochrome is now present as P_{fr}), the plant is briefly irradiated with far-red light (P_{fr} will now be reconverted to P_r) and then put into darkness, the leaflets will not close rapidly. If the far-red light is omitted before transfer to darkness or if red light is administered after the far-red and then the plant is put into the dark, the leaves will close promptly and vigorously. Thus, phytochrome can control leaflet closure, but only if the circadian rhythm permits any closure at all. The rhythm may be thought of as controlling a master valve and phytochrome a subsidiary valve that works only if the master valve is open.

Recalling that leaflet movement depends ultimately on the transport of potassium from one set of pulvinal cells to another, we can now ask how phytochrome regulates potassium movement. One provocative suggestion, put forth by M. J. Jaffe of Ohio University, is that phytochrome somehow regulates the quantity or release of acetylcholine at the membrane of the motor cells of the pulvinus, and that this, in turn, accounts for the movement of potassium out of a cell. This mechanism is clearly borrowed from the animal world, for it is known that acetylcholine is one of the substances that transmit stimuli from one nerve cell to another across the synapse, or gap separating the two cells. Because transmission of neural impulses is correlated with changes in the sodium and potassium balance of the cells, the proposed mechanism would appear to be logical. The postulate was also supported by the fact that root tips can be shown to change their surface electrical charges reversibly upon irradiation with red and far-red light, leading them to adhere to, or be released from, negatively charged surfaces. This change in surface charge can be related to secretion of positive ions like potassium.

Using the beating of an excised clam heart to measure the amount of acetylcholine in plant extracts, Jaffe was able to find correlations between the amount of the substance and the state of phytochrome. In support of his views, several other investigators found that the application of acetylcholine to plant tissues can cause effects that mimic the action of light absorbed by phytochrome. But the issue is not yet settled, for still other workers, including some in my own laboratory, have come up with some negative evidence. The answer to this problem will probably not be definitely obtained until new kinds of experiments are devised.

Acetylcholine is not the only neurotransmitter substance that could be involved in this plant response. Not only does acetylcholine exist in plants, together with the enzymes that make it and break it down, but so do other active neurotransmitter substances, such as serotonin, epinephrine, and norepinephrine. We are currently investigating their possible role, in leaf movements and other rapid plant responses. Attention has also recently focused on a substance called cyclic adenylic acid, which acts as a "secondary hormone" messenger in many animal responses and appears to be able to elicit numerous responses in plant tissues as well. Finally, the fact that the well-known plant growth hormone indoleacetic acid is chemically closely related to serotonin has not escaped notice.

It would be poetic justice if substances discovered by animal biochemists and pharmacologists were to play an important role in solving problems in the physiology of plants, whose numerous products—such as atropine, curare, LSD, and digitalis—have been of such aid to animal physiology and medicine. And if one of the neurotransmitter substances of animals should prove to explain plant leaf movements, the unity of basic biological mechanisms would be further emphasized.

Columnist Arthur W. Galston teaches biology at Yale University.

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The Silent Ordeal of a South Atlantic Archipelago

The Falklands' varied wildlife, threatened for two centuries by hunters and settlers, still struggles to adjust to man's presence

by Ian J. Strange

Isolated, bleak, and nearly void of human life, the Falkland archipelago rises in the South Atlantic Ocean some 250 miles off the southeast coast of Argentina. For years its ecosystem was disrupted, first by the crews of whaling and sealing ships, then by settlers. Its abundant wildlife was plundered and its soil was eroded because of man's carelessness and disregard for ecological values.

Millions of seals were indiscriminately butchered for their hides and oil. When they became scarce, penguins—whose eggs had been frequently taken for food—became a secondary source of oil. Introduced by voyagers and settlers, cattle and sheep overgrazed the predominant, soil-binding tussock grass (*Poa flabellata*), and the soft, peaty earth, exposed to the characteristic strong wind and rain or snow, was blown or washed into the sea. Although more care is now being shown for the islands' ecology, the dominant sheep industry, which supports most of the archipelago's 2,000 inhabitants of British descent, still is more concerned with increased revenues from wool sales than it is with the future of the archipelago.

The Falklands cover a total area of about 4,620 square miles and comprise some 340 islands, ranging in size from sea-lashed islets to the two main islands, East and West Falkland. It is a subtly colored land of grays and buffs, of treeless rolling plains and great rocky expanses of tundra; and the only exceptions to its generally low altitude are Mount Usborne on East Falkland with an elevation of 2,312 feet and Mount Adam on West Falkland, 2,297 feet.

Soil cover at the higher elevations is usually thin, with gray quartzite ridges dating from the Paleozoic and Mesozoic eras breaking the line of the rolling landscape. Sweeping down from the higher elevations are "stone runs," a geographical feature common to the Falklands. Composed of angular quartzite blocks, they appear on the landscape as huge gray rivers flowing down the hillsides and across the floors of valleys.

Many changes have taken place in the natural vegetation and wildlife of the Falklands since man first settled the islands. The first recorded landing was made in 1690 by the British navigator John Strong, but it was not until 1764 that the French established the first settlement under Louis de Bougainville. And it was not until 1842 that permanent colonization was begun under the British crown. Even prior to the 1840s, the cattle, pigs, horses, and goats introduced by whalers and sealers drastically overgrazed the islands. With the devel-

Fur seals, once common throughout the Falkland Islands, were nearly exterminated by sealers during the 1800s. They now number about 16,000 and breed only in isolated areas of remote islands.

opment of the sheep industry in the 1860s, this problem became more severe. Sir Joseph Dalton Hooker, the botanist on Sir James Ross's Antarctic expedition, which visited the islands in 1842, described many native plants, some of which are difficult to find today, as being abundant. Bluegrass (*Poa alopecurus*), cinnamon grass (*Hierochloë magellanicus*), and wild celery were recorded as covering large areas of the main islands. The predominant and valuable tussock grass, also known as "penguin grass," had already been destroyed in many areas of East Falkland by the herds of wild cattle and pigs originally introduced by Bougainville, but it still grew in coastal belts often several hundred yards in width.

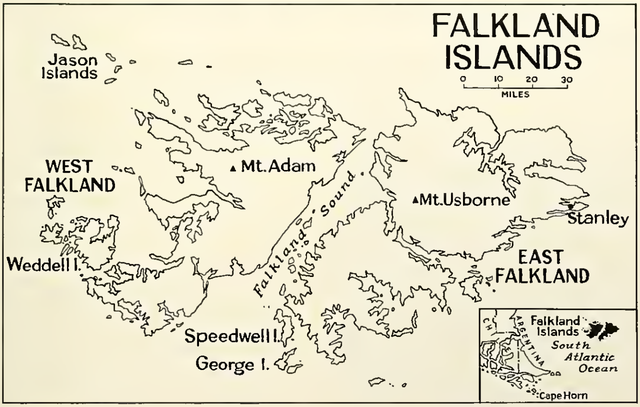
Today, however, there remains little evidence to show the original extent of the tussock grass on the main islands and many of the other plants are now found only in isolated areas. Taking their place are coarser plants, such as white grass, red crowberry, and ferns.

Without doubt, the most important natural vegetation in the Falklands, both to certain sections of the sheep industry and as a wildlife habitat, is the tussock grass; yet this grass now survives in only a few isolated areas of the main islands and on some smaller offshore islands. From a survey made in 1970–71 of pure stands of this grass on offshore islands, I calculated that probably no more than 12,000 acres remain.

Tussock is indigenous only to the coastal areas of the Falklands and other subantarctic islands where there is an abundance of sea spray and wildlife. The grass grows in soils enriched by bird and seal excrement, and the birds in turn greatly rely on its rich growth as a habitat. More than 50 percent of the Falklands' breeding species depend, either directly or indirectly, on tussock grass for their survival.

With the elimination of the tussock grass from the main islands, bird and animal life was greatly affected. Species such as the tussac bird, Falkland thrush, and other insect-eating birds lost valuable feeding grounds. The gray-backed storm petrel, which typically forms burrows in the fibrous base of the plants, lost much of its nesting territory, as did other species such as the sooty shearwater and the white-chinned petrel. As the tussock grass was killed off and erosion began, nesting burrows were completely exposed. I have found shearwater eggs in almost entirely open burrows, subject to destruction by both the weather and predators.

The Magellanic penguin, although affected by the loss of tussock, was able to adapt to the changed environment more easily than other birds. Where its nesting burrows were exposed, the bird tended to move farther inland or to other suitable open ground. It now uses two types of habitat: the areas where tussock still remains, such as the smaller offshore islands and a few areas on the mainland, and the open coastal areas of the mainland. In the latter areas, farmers are faced with the problem of soil erosion caused by the burrowing of the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Cape Horn

The undulating interior of East Falkland and the other large islands is broken only by hedges bordering pastures and sheep farms. The coarse grasses of these landscapes contain little of nutritional value for cattle.

penguin. Ironically, the bird is being blamed for the same problem man originally created when he allowed unrestricted grazing of the tussock.

Where dense stands of tussock grass are still found, the Magellanic penguin burrows beneath the hummocks. Here the burrows remain stable, there is no erosion, and the plant and bird benefit from each other's existence. Under natural conditions, both seals and birds intercultivate the tussock by their passage between the plants. Dead and decaying leaves are effectively broken down by trampling, and nitrogen-rich residues in the form of excreta quickly form into highly fertile soil.

Notable exceptions to the destruction of the tussock occur where the grass has been preserved by farmers who see it as a valuable feed for stock. They also appreciate birds like the Magellanic penguin, which supply valuable nutrients to the grass. On a few offshore island farms the grass is carefully fenced off and during the summer season, when the penguins nest in the tussock, stock are not allowed to feed on the grass. During the summer the plant forms a leafy growth that remains green throughout the winter, at which time stock are allowed to feed upon it.

As sheep raising brought changes in the islands' vegetation, the islanders' attitudes toward certain bird species also changed. Large numbers of upland and ruddyheaded geese have always been a feature of the coastal areas, and since the islands were first settled, they have been an important meat source. Until the late 1800s, the flocks of wild geese were accepted as a normal part of the Falkland scene. But changes were taking place in the natural pastures. Because sheep were allowed to graze without restriction, the finer grasses disappeared and coarser shrubs and white grass replaced them. Consequently, sheep depended more and more on the finer coastal "greens," including tussock, the natural habitat of the wild geese. Since 1903, farmers, viewing the geese as competitors of the sheep, have made efforts to eradicate them.

Sheep farmers do recognize that, unlike the goose, the gentoo penguin creates valuable grassland. Preferring the more open habitat of the larger islands, the gentoo penguin was affected little by the disappearance of the tussock grass from the mainlands. This penguin lives gregariously in colonies that may number many thousands of pairs. Each breeding season the colonies move their nesting sites—sometimes only a few yards from the previous season's site—in search of new nesting material. Typically they take coarse vegetation, which they pull to pieces for nest construction. Wherever a new rookery is made, the vegetation is usually completely destroyed, and at the close of the breeding season all that remains is a mat of rotting nest material. The soil, now rich in excreta, quickly grows fine grasses, and rarely do such areas revert to their former covering of shrub and fern. Because this finer grass is of great value to their stock, some farmers are now making efforts to conserve the colonies of gentoo penguins on their land, even to the extent of preventing the collection of their eggs.

Predictably, with the arrival of man on the Falklands there came rats and mice. On the larger islands their effect on the bird life was not too noticeable, but where they were deposited on small offshore tussock islands, they have profoundly affected both bird life and vegetation. Ground-burrowing petrels vanished from such areas, and passerines were reduced to a point where certain insects, a favorite food of passerines, are now unchecked and endanger the tussock growth.

The introduction of rabbits, hares, and the Patagonian fox has in some regions created problems. The fox, fortunately, was introduced only to some offshore islands, where it remains a problem to the sheep farmer. During the 1930s, when it was first introduced, its effect on bird life was devastating. With the disappearance of penguin colonies and ground-nesting birds from these islands, the fox was forced to adapt its feeding habits. It took to the shores, seeking shellfish and other marine life, supplemented by wild fruits from inland areas. Such food must now be accepted by these animals as their staple diet, for on some of these islands bird life is increasing with no apparent interference from the fox.

The destruction of the tussock grass, and its effect on many bird species, was achieved over many years. A gradual event, it was accomplished at the hand of, but not directly by, man. Elimination of the tussock meant extermination for some species, but it was not outright butchery. Yet butchery also took place. Following the first settlement of the islands in 1764, there began a plundering of wildlife that continued for well over 150 years.

Bougainville was probably the first to engage in whaling and sealing about the Falklands. Other French opportunists followed, and by 1774 American whalers were working around the islands. A few years later the archipelago experienced the first major blows to its seal rookeries. After the near decimation of the northern fur seal colonies in the North Pacific between 1750 and 1775, sealers began to look for new sealing areas. Adventurous skippers made their way to the South Atlantic and discovered that the southern species of fur seal was a near relative to the northern type and of equal commercial value.

In 1784 the first experimental cargo of fur seal pelts, numbering some 13,000, appears to have been taken from the Falkland Islands by an American vessel from Boston. Complete decimation of the colonies was avoided only because larger fur seal colonies were discovered a thousand miles to the south on South Georgia Island and the South Shetland Islands.

One of the first sealers to work the islands was an American, Edmund Fanning, who on a visit in 1792 wrote in his journal, "On our arrival, we learned that the seals were up in great numbers on some of the outer islands. At Beauchene Island, for instance, the top of a rock forming the northeastern head of the island was . . . covered with fur seal. There were also at the island many other American sealers."

Today Beauchene Island, the most remote island in the archipelago, some forty miles offshore from the main Falkland group, is the breeding ground for millions of seabirds but no fur seal. This formidable island, with its towering cliffs and unapproachable shores, had for many years been the home of thousands of seals.

In 1963 I made my first visit to Beauchene Island, the second landing that had been made on the island in forty years. One of my principal purposes was to search its rugged but short coastline for evidence of seals. Inscriptions cut into the rocks by early American sealers and later, by local exploiters, giving name, date, and number of skins taken, point to the steady decline of the Beauchene rookeries. The last inscription, cut in 1919, probably bears witness to the fate of the animals on the island. No number is inscribed after that date. Records show, however, that after spending two months on the island in that year, the two sealers holding licenses for the region returned with only eleven skins, doubtless the final remnants of what had been one

Where gentoo penguins nest, the richly fertilized soil produces thick stands of fine grasses. Such grasses are of great value to grazing sheep.

Rockhopper penguins, at right, find various forms of marine life in the kelp beds around the islands. Kelp is harvested commercially and ground into meal as a dietary supplement.

of the Falklands' largest fur seal colonies.

The South Georgia and South Shetlands seal colonies, while reaching the point of near extinction, have apparently recovered, and the colonies are still increasing in size. Although also growing slightly, the Falkland herds are still very small. The 13,000 seals taken in 1784 would represent a large proportion of today's total fur seal population on the archipelago. Surveys I made in 1965–66 indicated that the population at that time numbered some 15,000 to 16,000 animals.

There are two other species of seals in the Falkland Islands: the southern sea lion and the southern elephant seal. In the early days the latter was hunted extensively for its oil, and by 1871 it was thought to be extinct in the Falklands. Over the last thirty years, however, this seal has made a dramatic comeback and its population is increasing. The sea lion population, on the other hand, has shown a marked decline, which in all probability has worsened over the last nineteen years. A survey of this species made in 1936–37 estimated the herds at 370,000, whereas a more recent survey I made in 1964–66 put the total population at not more than 30,000, of which no more than 6,000 were pups. Checks of specific colonies made in 1970 gave little indication of any changes in the status of the species since 1966.

There appears to be no clear-cut reason for this decline. Certainly it is not due to exploitation by man. Initially, as the more valuable fur seal and elephant seal became scarce, the sea lion was taken for its skin and oil. Recently, however, commercial exploitation of the sea lion has been only sporadic, and all such ventures have ended in failure due to the shortage of the species.

One reason for the decline may be that the species will not tolerate a great deal of human interference and, in certain areas, disturbance by sheep-farming activities may have had an effect on some populations. A larger reason may be that the complex food chains of the seas have changed. Evidence of the sea lion preying upon the penguin, which is not its usual food, has increased dramatically over the years, but whether this is an indication of a food shortage is not entirely clear.

Elephant seal and, to a lesser extent, fur seal populations are increasing. Because both these species have different feeding habits from those of the sea lion, food competition is not a cause of its decline. Perhaps disease is a reason. Although we may be able to control the exploitation of such creatures, we should also remain mindful of any natural disasters over which we have no control.

From a very early date, the huge colonies of penguins found in the Falklands served a useful purpose to whalers and sealers. The eggs of these birds became a valuable item of diet. In his journal Edmund Fanning describes how the eggs were preserved by immersing them in seal oil and then storing them in wooden casks. At New Island crews of whaling vessels developed a business of collecting, storing, and selling enormous numbers of penguin and albatross eggs to visiting ships.

Of the five species of penguins breeding in the archipelago, three are common and represent the largest group of birds in the islands. The rockhopper is the most abundant; aerial surveys, coupled with ground counts, indicate that the largest single colony in the Falklands exceeds two million birds. Other large rockhopper colonies exist in the islands, and a total population of some five to six million

The rookery of black-browed albatrosses on Beauchene Island has pushed the tussock grass back from the shore. The clumps of dirt, right foreground, are the remains of tussock roots.

The striated caracara, a rare hawk species, lives only on the Falklands and several islands off Cape Horn. At left, an adult and two juveniles perch on tussock clumps, where the species often nests.

birds would not be an unrealistic figure.

The Magellanic penguin is also common, with a total population estimated to approach that of the rockhopper. The third most common penguin is the gentoo, with an estimated population of some 100,000 breeding pairs. The king and macaroni penguins are uncommon in the Falklands; my own figures for the former species indicate fewer than fifty breeding pairs.

In about 1820 the vast penguin rookeries came to the attention of sealers as an alternative source of oil. The American schooner *General Knox,* lying in the harbor of West Point Island, is thought to have been the first to take this type of oil to top off her barrels of seal oil. So started another phase in the exploitation of island wildlife.

How long penguin oiling lasted is not clear, but it reached its height in 1864 when seven vessels were being operated by local colonists. The rookeries on Bird, Speedwell, and Arch Islands were decimated, and from 1864 to 1866 some 63,000 gallons of penguin oil were brought into Port Stanley for shipment to London and other European markets. It is generally accepted that eight rockhopper penguins produced one gallon of oil.

The larger gentoo penguin was certainly taken from areas such as Speedwell, Grand, and Steeple Jason Islands. On Steeple Jason Island one can still follow the low stone walls that run for over a mile in length, along which gentoo penguins were herded from the sites of their colonies to corrals where they were killed.

How many birds were destroyed is not known. The oilers had little interest in statistics, but available records indicate that nearly two million birds were required to produce the oil obtained. Through wastage probably some two and a half million birds were killed.

No doubt following the habit of sealers and whalers, the collection of penguin, albatross, and other wild bird eggs developed into a traditional activity of the Falkland settlers. In the early days of colonization such eggs were recognized as an important item of diet and, ironically, when a merchant dealing in penguin oil threatened to exterminate the rookeries in the vicinity of Port Stanley, Governor Moore had legislation enacted in 1862 to protect the birds that "provided eggs so necessary to the health and comfort of the inhabitants."

On Lord Mayor's Day, the islanders would by tradition start egg collecting with an "egging picnic." One of these forays resulted in the collection of some 13,000 eggs from little more than a mile of cliff. For the children, the spree was lengthened into Egging Week. Over the years many of the rockhopper penguin colonies could not stand the strain and eventually disappeared. One such rookery, which lay close to Stanley, the archipelago's only town, had an estimated total of 50,000 birds. Today that rookery no longer exists. In 1911, a record of 85,000 eggs was collected from Kidney Island; in 1952 the result of an extensive search resulted in the collection of only 1,000 eggs.

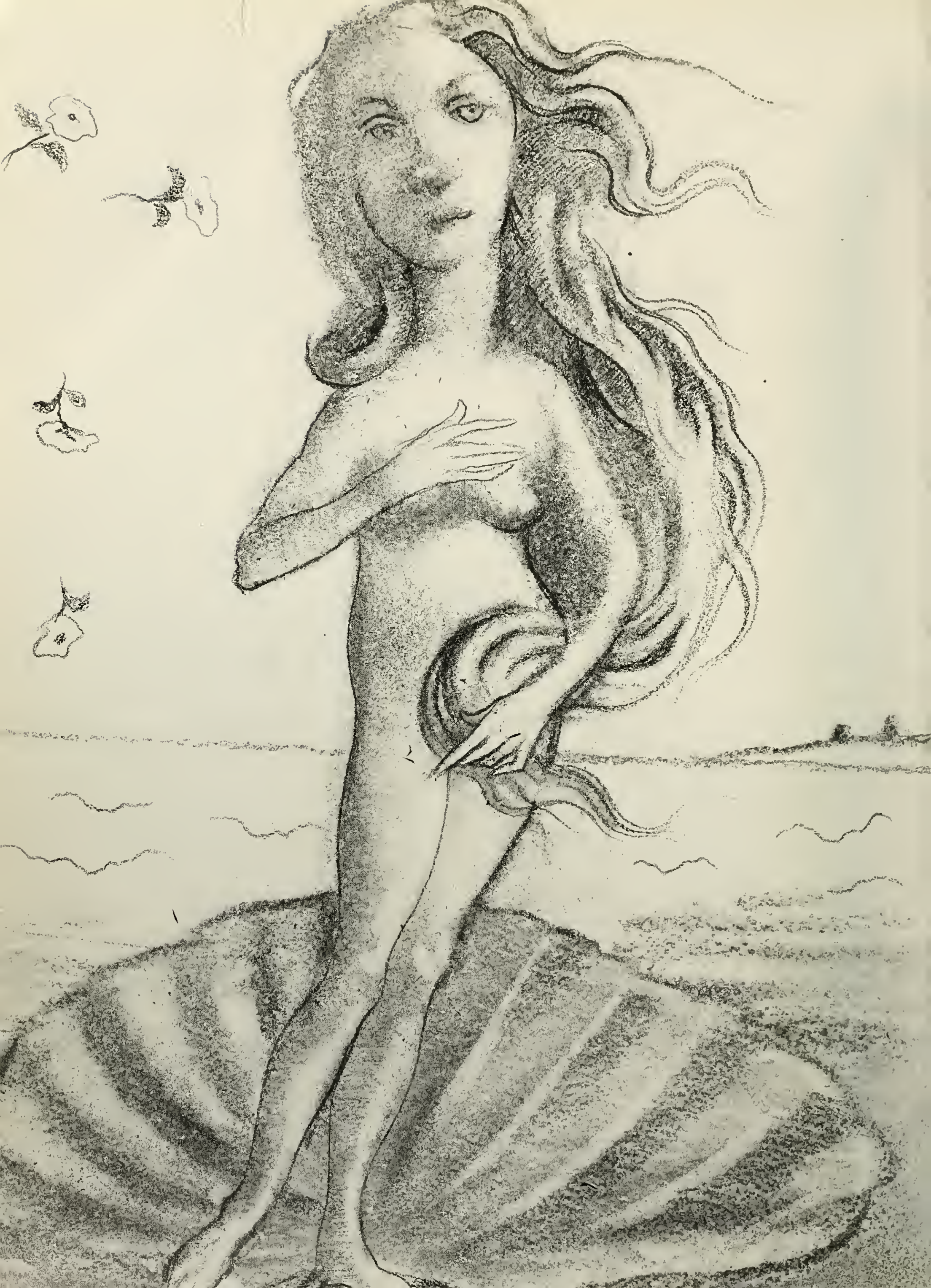
Egging is still an annual event, but it is carried out under license; between 1965 and 1970 an average of 32 licenses per year were issued for an average annual collection of 39,516 eggs. It is possible that more eggs are collected unofficially, for there can be little control. The indication is, however, that egg collecting is not popular. Certainly wild bird eggs are no longer regarded as an important item in the islander's diet.

Despite the plundering by sealers and the penguin-oil industries, the Falklands remain rich in bird and animal life. A fairly large number of island sheep farmers argue that since the fauna has survived man's activities for more than 150 years, it will therefore continue to survive. Sheep farming has remained the only stable industry of the Falklands, and as such, is of undisputed importance to the survival of the islanders. Regrettably, it is this one industry that presents the greatest threat to the future existence of the Falklands' wildlife.

Over the last ten years, however, the islands' population has made considerable progress toward correcting its 150-year history of wildlife exploitation. In 1964 two ordinances were brought into force by the Falkland government: one for the protection of birds and animals, the other for the establishment of wildlife reserves. By the end of 1970, seventeen sanctuaries, covering 9,500 acres, had been set aside. Two of these embrace extensive areas on East Falkland. The remainder are on offshore islands that vary in size from 42 acres to 946 acres.

There are also four wildlife reserves totaling 1,306 acres. Private acquisition of two large islands in the Jason Island group has added another 5,424 acres to the reserve system. In 1972 I acquired an 8,000-acre island, which is to be established as another reserve. For such a small land mass, these steps are encouraging.

For many years the islands remained remote to the outside world. Many of their conservation problems were internal, but now various forms of pollution are reaching their shores. The surrounding seas are being opened up to the world's fishing fleets, a new form of exploitation aimed at the food so much of the islands' bird and animal life depends upon. It is not known whether the Falklands can face and survive another round of exploitation. ■



From Mother Goddess to Dishwasher

by Dena Justin

Sometimes she appears as Cinderella's cruel stepmother, sometimes as Hansel and Gretel's scheming witch or the adulteress-queen of the *Arabian Nights* or the jealous co-wife in an African folktale. While the nuances of her role vary, her identity remains the same. The surrogate mother, folklore's formulaic agent of evil, shares a common lineage with Eve. She is a debased manifestation of the Great Mother Goddess at whose altars the ancient world once knelt.

In perpetuating the calculated distortion by males of the female principle, Cinderella's stepmother is, I suggest, a carefully programmed conception in a manipulative process that began thousands of years ago with the advent of trade and bronze weaponry, urbanization and the dynamic state. Or, as mythology tells it, with the triumph of the patriarchal deities of the sky cults over the matriarchal deities of the earth cults. Today's feminist manifestos inevitably fall upon ears made deaf by what may be the oldest and most effective propaganda campaign in human history, a campaign transmitted across the eons through the powerful mass media of mythology, cosmology, and folklore. The Brothers Grimm, Andrew Lang, the anonymous compilers of the *Arabian Nights*, represent only the latter-day purveyors of the message that successfully restructured the fabric of our civilization and diminished women to a "second sex"—their identities shaped and their roles defined by the social and economic needs of men.

The earth as Mother, the womb from which all living things are born and to which all return at death, was perhaps the earliest representation of the divine in protohistoric religions. The Great Mother Goddess, a more powerful incarnation of the female principle as life-force, reigned over the sky, earth, and underworld, and revealed herself to humankind in the ever renewing productivity of the earth and the ever recurring rhythms of the new, full, and waning moon. Her subordinate male-consort was the young god, alternately her son and her lover, who died with the harvest and was reborn with the spring seed. And woman, who shared the prodigious magic of procreation and nurture, whose menstrual cycle mysteriously coincided with the lunar cycle, was the terrestrial link in this cosmic orbit of fertility.

How old is the Great Mother Goddess, and the religious revolution that thrust her into the background and subjugated her sex? Existing mythologies are of comparatively recent vintage. Whatever information they yield concerning the former goddess comes to us

**With the aid of myth and folklore,
men fought and won the battle of the sexes
thousands of years ago**

carefully siphoned by the male victors. Archeology digs deeper—and with less bias. Nude female figurines (the Venus of Willendorf, *ca.* 25,000 B.C., is the best-known example) appear to have been the earliest cult objects of humankind. These fertility statuettes with pendulous breasts and bulbous loins, carved out of bone, stone, or the ivory tusk of the mammoth, have been found in widely scattered sites of the Aurignacian period. Uncensored, they tell us that for our Paleolithic ancestors, the generative force of the universe focused in the female body.

Yet even among these earliest races of our species, Joseph Campbell notes the evidence of a shift "from the vagina to the phallus, and perhaps too from an essentially plant-oriented to a purely animal-oriented mythology." At the rock shelter of Laussel, in southern France, and in Paleolithic camps from northern Spain to southeast Siberia, nude female figures of obese proportions, dating from about 30,000 B.C., have been found shattered beyond restoration. By the close of the Aurignacian, the many fertility statuettes enigmatically disappear from the European strata, while the hunting murals in the men's "temple-caves" grow ever more predominant, reaching their highest development about 20,000 B.C., in the Magdalenian age. Campbell suggests a deliberate design by men to break the "magical" power of women by a "consciously contrived mythology"—a preliminary battle in what was to become a continuing war of the sexes. "It may be," he concludes, "that the main idea has been not so much to honor God as to simplify life by keeping women in the kitchen."

Worship of the Great Mother Goddess peaked during Neolithic times with the development of agriculture by women. This newly found capability of influencing the earth's fertility and insuring the rebirth of the seed gave woman a dominant position in the economic and social structure of early agricultural societies. As cult priestess of the Great Mother Goddess, she possessed the powerful knowledge of magic, rainmaking, and prophecy.

It is remarkable how many legends survive among preliterate cultures of an earlier matriarchal period and a violent uprising by men in which they usurped female authority. Rupture from the mother, both biological and religious, constitutes a basic motif in male puberty rites. Among the Papuans of New Guinea, the initiant treads over his mother's belly to symbolize the severance. Although in some societies initiation rites entail no more than the means to clan membership, in others, the ordeals of such rites often represent a spiritual journey into a higher state of being. To achieve his integration into the community of men, the novice must undergo ritual death in the maternal "profane universe" and be reborn into the paternal "sacred universe." This mystic dichotomy—the maternal as profane and the paternal as sacred—follows an archaic and worldwide pattern. In the enactment of the rites, the adolescent male is often subjected to homosexual practices by his elders, perhaps to condition him to scorn women and fear the female genitalia, depicted as the "toothed vagina." There are societies, however, where homosexuality occurs because women are considered sacred and inviolable.

A myth of the Selk'nam of Tierra del Fuego provides an illuminating preface to the rites. In the beginning the sorceress moon woman, Kra, taught women to dominate men through terror, transforming themselves into spirits by the use of masks. But the sun man, Kran, learned the secret and revealed it to the men. They promptly killed the women, sparing only the girls, and to legitimatize their seizure of power, they took over the masks and the magic. According to Leo Frobenius, the nineteenth-century anthropologist, this type of insurrection underlies the formation of all male secret societies in preliterate cultures: the societies of the masks were an outgrowth of matriarchy, organized by men to maintain their control.

Literate societies have been more cryptic in dealing with the protohistoric struggle between the sexes. They have either cloaked it in mythological imagery or ignored it. The universe begins from a tension of moral opposites, defined by Pythagoras as the good principle, which created order, light, and man, and the evil principle, which created chaos, darkness, and woman. The form that this misogynist doctrine takes in mythology and scriptural writings manifests a systematic division into three parts.

First, there is the myth of the male as sole genitor, which would appear to bear out Eric Fromm's contention that the antagonism between men and women arose from pregnancy-envy, not penis-envy. To oust women from their position of power and esteem, it was not enough for the paternal gods to depose the Great Mother Goddess throughout her vast domain, to take over her shrines, to shatter her images, to fragment her prerogatives. These were only peripheral elements of her hold on her worshipers. As bearer and nurturer of progeny, woman's focal role in family, tribe, and race survival was obvious. In order to achieve religious, social, and economic supremacy, man had to strike at the source of her pre-eminence, her biological role in procreation.

Mary Jane Sherfey has recently reported on "the best-kept secret in the history of biology": the recognition in the 1940s that all mammalian embryos are initially female, and that the penis is an enlarged clitoris. Mythologically speaking, the ancients scooped our modern-day biologists by unknown thousands of years in their recognition of the female principle as the primal creative force. And they too buried the truth, restructuring the myths to accommodate male ideology.

Both the old and the revised theory of creation, disavowing the female principle, appear first in Sumer, the Mesopotamian matrix of culture from 3500 to 1750 B.C. Samuel Noah Kramer affirms that the Sumerians regarded the primeval sea as "a kind of first cause and prime mover." From his studies of the cuneiform texts, he has established that the Sumerians considered Nammu, the goddess of the primeval sea, as the primal generative force of the universe, the cosmic mother who gave birth to the male An, representing heaven, and the female Ki, representing earth. They in turn parented Enlil, the air god, who separated the two and, uniting with his mother, completed the organization of the world.

The Babylonian creation epic, *Enuma Elish*, dating from the early part of the second millennium B.C., and like most Mesopotamian myths derived from Sumerian prototypes, shows significant alterations. The poem casts Marduk, the Babylonian Enlil, as the primordial genitor who brings forth the universe and all it encompasses by the divine force of his word. But the creation is, in actuality, a re-creation, which takes place only after a cosmic battle between Order and Chaos. The victorious Marduk-Enlil represents Order. The vanquished Tiamat, the Babylonian Nammu, goddess of the primeval sea, incarnates Chaos. Marduk fashions the new heaven and earth out of Tiamat's severed body.

From Egypt's earliest documents, written about 3000 B.C., Rudolph Anthes has concluded that in prehistoric times the Egyptians also conceived the primeval sea as the ultimate generative principle. Out of the sea arose the primeval earth hill, a symbol of the womb, akin to the Greek *omphalos* stone, the sacred navel. A female divinity was envisaged as the cow in the primordial waters, and eventually identified in historic times with Hathor, the cow-goddess. Egyptian art depicts Hathor as the "waters of the sky," in the form of a cow: her body the starry firmament, her legs the four quarters of the horizon. Her role as primal creator, however, is appropriated by the god Atum, who, rising out of the earth hill, mythically initiates the divine genealogy by masturbation. When Memphis was established as capitol of Upper and Lower Egypt during the First Dynasty, the Memphite theologians proclaimed their male patron-god, Ptah, the first principle. Ptah conceived the universe and all therein by the divine force of his heart and tongue, the archaic Egyptian equivalents for mind and speech.

When we reach the Old Testament, the female principle has disappeared from the genesis of the universe. Indeed, woman herself becomes a supplement to the male issue. God fashions Eve, the Mother of All Living, from Adam's rib. Even her name attests to the demeaning nature of her origin. The Old Testament says ". . . she shall be called woman, because she was taken from man." She is a lesser being, "a misbegotten female . . . made in the image of man, not God," declares Thomas Aquinas.

Hesiod, the Greek mythographer, relates that in the beginning there was Chaos, and then wide-bosomed Gaia, Earth, came into being, the ever immovable source of all the gods. Nevertheless, Athene, a former Great Mother Goddess, acquiescing to the demands of Olympian patriarchal mythology, emerges full-grown and helmeted from Zeus's head. "No mother bore me for her child," she states unequivocally. The Greeks, who prided themselves on their devotion to knowledge by rational pursuit, felt constrained to buttress this blessed event with biological argument. Apollo, the god of reason himself, presents the physiological basis in Aeschylus' *Eumenides:* "The mother of what is termed the child is not its parent, but only the nurse of the newly impregnated seed."

Despite a timeless and exalted tradition of matrilinear succession to the throne, and the high status of Egyptian women throughout antiquity, Egypt echoed this dogma. "They [the Egyptians] maintain that the father is the sole author of procreation," Diodorus Siculus writes. "The mother only supplies the fetus with nourishment and a place to live; and they call the trees that bear fruit 'male' and those that do not 'female.' "

Having established, through holy writ, both creation and reproduction as the unique endowment of the male principle, the second objective of male strategy—the subordination of women in the social and economic spheres—would be comparatively simple to execute. Who shall dispute what the gods have willed? In Greece women were deprived of their political and social authority, not by the connivance of self-seeking men, but as the consequence of Olympian design. Athene, the "lost leader," defeats Poseidon, the sea god, for tutelary control of Athens, but yields to male pressure. Descent will henceforth be patrilinear, not matrilinear. Children will no longer be called by their mother's name, but by their father's. Women will be disenfranchised and deprived of citizenship. Apollo seizes the oracle of prophecy and law-giving at Delphi from the earth-goddess whose domain it has been since the beginning of time. Here, where the *omphalos* stone, awesome symbol of the universal Mother, marked the earth's center, Apollo inscribes the precept of the new order: "Keep women under rule."

In the Old Testament God informs Eve ". . . and thy desire shall be to thy husband, and he shall rule over thee." Saint Paul declares the husband is the head of the wife even as Christ is the head of the church. And Thomas Aquinas defines woman's subjection as the result of sin: "Therefore it was decreed that she shall be under men's power." The Koran, too, states that "men are superior to women because of the qualities in which God has given them pre-eminence."

The Brahman juridical code, the Laws of Manu, proclaim that a woman may never act independently. In childhood she must be subject to her father, in youth to her husband, and when her lord has died, to her sons. "Even though her husband is totally devoid of virtue, or seeks pleasure elsewhere, he must nevertheless be worshiped as a god." The Jain Yogi is told that women cannot attain Nirvana because they are incapable of self-control. Deceitfulness is as natural to them as teaching the law, to sages.

The *coup de grâce* in this systematic decimation of the female image is the *mythos* of woman as the destroyer of mankind, prime cause of Paradise Lost, precipitator of the Fall, begetter of all evils. The broken texts relating the Sumerian flood story make it difficult to assess the role of the mother-goddess, Nintu, or the love-goddess, Inanna, in the oldest recorded destruction of humankind by divine retribution. But Egyptian mythology leaves no room for doubt concerning Hathor's role. The solar deity, Re, king of gods and men, learning that the people are plotting evil, dispatches Hathor, the cow-goddess, to punish them. She does so thorough a job that when night falls, the blood of her victims has inundated the desert. Re, appalled at the prospect of humanity's extinction, orders his servants to cover the fields with seven thousand gallons of beer mixed with red ocher. When Hathor returns at dawn to complete her grisly task, her heart fills with joy as she perceives the blood-red expanse. The irony of it—Hathor, the gentle cow-goddess who suckles the Pharaohs and nurtures the entire universe with her life-giving milk, whose eternal bounty overflows into the Milky Way. Now her reflected face grows radiant as she slakes her heinous thirst for human blood. The goddess becomes inebriated by the beer, according to plan, and reels back to heaven, her monstrous mission unaccomplished. The ingenuity and compassion of the father god, Re, has saved humanity.

Man's tragic expulsion from Eden, all our earthly travail, we owe to Eve. She, the Mother of All Living, ate the forbidden fruit, tempted Adam, and precipitated the Fall. It was then that they saw their nakedness, then that woman and sexuality became the formula for sin. Tertullian denounces her as the devil's doorway, one who should always go in mourning and in rags to expiate her wickedness.

The ancient Greeks, too, invested woman with the guilt for human suffering and misfortune. Pandora, whose name means "all gifts," the beneficent source of nature's largesse, is one of the earliest of the Hellenic earth-goddesses. Hesiod's patriarchal genealogy of the gods refashions her into a creature of clay, a wily seductress, who ensnares men by her beauty and brings gifts of sorrow to humankind. Goaded by the willful disobedience and insatiable curiosity that characterize women in male annals, Pandora opens the gods' forbidden jar and unleashes lust, plague, vice, and toil, all the manifold woes of human existence. Fortunately, the shrewd Olympians, knowing women, had also put hope into the fateful jar. Thus we mortals are not totally bereft.

The Great Mother Goddess has been toppled from her throne, her role as cosmic genitor effectively erased from the world's cosmogonies. The reason for woman's subordinate status and "natural" inferiority has been unequivocally established through the omniscient word of the divine or secular explanations of the divine intent.

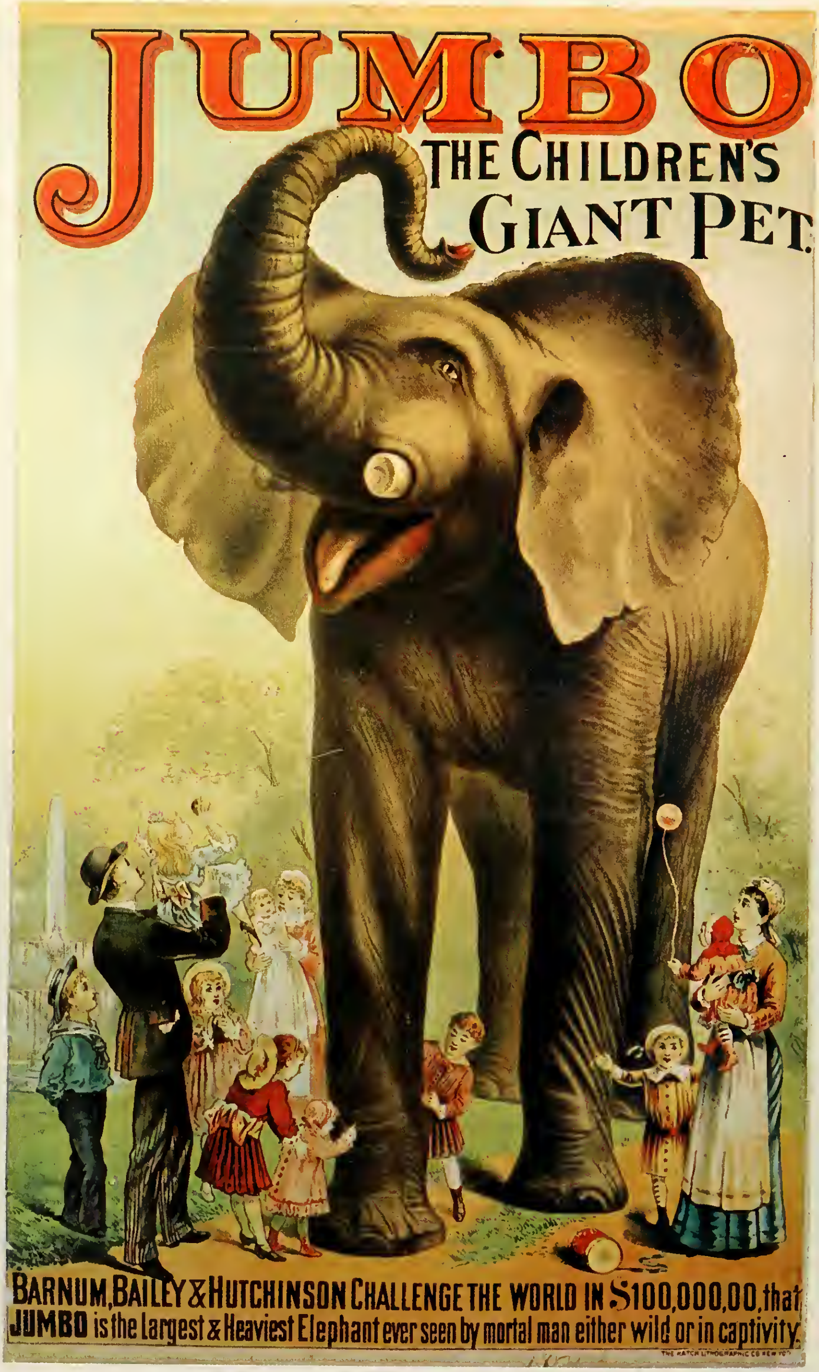
Folklore provides an ingenious capstone. Sigmund Freud was the first to observe that the symbology of myth and dream are the same, a common language of the subconscious spoken by all people the world over since the dawn of history. Folktales employ this same symbolism, channeling the subconscious fears of childhood—of separation, loss of love—into the realm of nightmare. The mother who loves, nurtures, and protects all her children, impartially, becomes the cruel stepmother, the plotting queen, the wicked fairy, the varied surrogate mother figures subsumed by folklore into "the witch." It is her powers of sorcery that turn Prince Charming into a lion, a dove, a swan, a crab, a frog. The giants and dragons who bedevil hero and heroine are also creatures of the earth mother. The giants, derived from the Greek *gigantes*, were born from Gaia, the earth-goddess. It was they who attempted, unsuccessfully, to overthrow the Olympians.

Prince Charming, like the Mesopotamian Gilgamesh, the Hellenic Hercules and Perseus, and Maui, the Maori hero of Polynesian myth, must surmount the supernatural challenges of initiation in order to break the sorceress' hold and live happily ever after with the princess. The heroine of the fairy tale is sometimes the self-effacing, hearth-tending Cinderella or Snow White. More often, she is the pampered, self-centered "little princess," who feels the pressure of a pea under twenty mattresses. It is she who usually lengthens the prince's thralldom and their mutual suffering by disobeying his orders or by yielding to her insatiable curiosity.

So subtly have our nerve ends been twisted against our own reason that we accept the resolution of the *Arabian Nights* as a routine happy ending. The virtuous and talented Scheherazade has won her reward. She will share the bed of a psychotic sex-killer forever after. The sultan who rapes a different maiden nightly and murders her at dawn has become Prince Charming.

Although the witch, incarnate or in surrogate mother disguise, remains a universal bogey, pejorative aspects of the wizard, her masculine counterpart, have vanished over the patriarchal centuries. The term *wizard* has acquired reverential status—wizard of finance, wizard of diplomacy, wizard of science.

A compassionate king named Urukagina, reigning in the Sumerian city-state of Lagash about 2350 B.C., instituted sweeping reforms to liberate his people from oppression by thieving bureaucrats and venal priests. Concerning these reforms, Kramer states that "we find the word 'freedom' used for the first time in man's recorded history; the word is *amargi*, which, as has been recently pointed out by Adam Falkenstein, means literally 'return to the mother.' However, we still do not know why this figure of speech came to be used for freedom." Perhaps Urukagina remembered a time when the motive force of human society was matriotism, concern for the individual, for the flesh-and-blood family, and this to him symbolized freedom. ■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Phineas T. Barnum's Charming Beast

by Harvey A. Ardman

The elephant that introduced jumbo *into our language was also the center of one of the greatest disputes between England and America since the War of 1812*

On Monday, April 10, 1882, nine thousand people, most of them children, crowded into New York's Madison Square Garden to see a performance of the recently merged Barnum and Bailey circus. Three thousand more were stranded outside, unable to get tickets. The crowd had come to see what that beloved old humbug, Phineas Taylor Barnum, had promised would be the greatest wonder he had ever displayed: "the largest elephant in or out of captivity," the world-famous Jumbo. They were not disappointed.

After the delays typical of a grand entrance, the band struck up a tune and the crowd's attention was directed to a door on the building's performance floor. Soon the giant animal appeared, led by his keeper of many years, Matthew Scott. The audience stared in disbelief. The newspaper stories had said Jumbo was large, but none of the spectators had ever seen a creature this size. Barnum claimed that Jumbo stood 12 feet high at the shoulder, weighed 10½ tons, and measured 26 feet long, including his trunk. But being a showman, Barnum often exaggerated. More reliable sources indicate that the elephant stood 11 feet at the shoulder and weighed 6½ tons.

As the elephant began to move, his small eyes blinking, his enormous ears flapping, the crowd broke into prolonged applause. Urged on by his keeper, Jumbo ambled around the circus' three rings, his great head swinging from side to side. As the crowd threw handfuls of candy and nuts toward him, Jumbo would stop, reach down with his trunk to pick up a helping of goodies, shove them into his mouth, then stride majestically on. After completing a circuit of the auditorium, he would disappear through the same door by which he had entered.

For the next three and a half years, Jumbo repeated his performance scores of times, for what Barnum said was a total of 9 million Americans.

No one knows exactly where Jumbo was born, but when he was captured in Central Africa, probably in 1861, he was a baby, only about four feet high. After being taken to the African coast by riverboat, he was sold to an animal collector, who in turn sold him to the Jardin des Plantes, the Paris zoo, with assurances that he would quickly turn into a monster. But African elephants only grow about five inches a year. By 1865, with Jumbo still well under six feet in height, the Jardin des Plantes gave up on him and traded him to the Royal Zoological Gardens in London for a rhinoceros.

For the Royal Zoological Society, Jumbo was a marvelous acquisition. Because he was the first African elephant to be brought to England alive, there was great excitement when he arrived in London on June 26, 1865. Three months later, he was joined in the Royal Zoological Gardens by another African elephant, a female named Alice.

For sixteen years Jumbo was one of the zoo's prime attractions. During that time a million and a quarter children, including the offspring of most of the crowned heads of Europe, rode in the howdah strapped to his broad back. Theodore Roosevelt saw Jumbo when he visited England, and the young Winston Churchill had his picture taken with the animal.

"Jumbo," wrote *Harper's Weekly* at the time, "was a universal favorite, as gentle with children as the best-trained poodle-dog, taking the proferred biscuit or lump of sugar with an almost incredible delicacy of touch, so that the most nervous child, having once overcome his alarm, never hesitated to hand a morsel to the waving trunk a second time."

Yet as Jumbo approached his seventeenth year of residency at the London zoo, it became clear that all was not well with him. He was entering the musth, a difficult period common to male elephants. Even now, the musth is not well understood, but it appears to be related to sexual development. As male elephants reach maturity, two small glands, located between the

Jumbo readily accepted handouts.

eyes and the mouth, exude a bitter, tarlike substance. Some experts believe that the substance, rubbed off on trees, signals female elephants that mating is desired. Occasionally, elephants become sexually aggressive in their musth period.

Whatever its biological function, the musth lasts from one week to five months, and during this period the elephant is angry and irritable. If it is in captivity, it may become unmanageable. In late 1881, in the midst of his musth, Jumbo acted up, doing considerable damage to his stall. His howdah was put away, and for the next few months, Jumbo was kept away from the public. As a result of Jumbo's restlessness, Abraham Bartlett, the zoo superintendent, wrote to the Zoological Society's council to express his concern.

> I have for some time past felt very uncomfortable with reference to this fine animal, now quite, or nearly quite adult, and my fear of him is also entertained by all the keepers except Matthew Scott, who is the only man in the Gardens who dares enter this animal's den alone. I have no doubt whatever that the animal's condition has at times been such that he would kill anyone (except Scott) who would venture alone into his den, but up to the present time, Scott has had, and still has, the animal perfectly and completely under his control. At the same time, I consider that the matter is of so serious a nature that I feel called upon to draw the attention of the Council to the subject, for in the event of illness or accident to the keeper (Scott) I fear I should have to ask permission to destroy the animal, as no other keeper would undertake the management of this fine but dangerous beast. In conclusion, I may ask that I should be provided with, and have ready at hand, the means of killing this animal, should a necessity arise.

It was the right moment for an agent of Barnum's to approach Bartlett and ask for how much the zoo would sell the beast. Today it is not entirely clear who took the initiative, but through his agent, Barnum offered £2,000 (at that time equal to $10,000) for Jumbo, and Bartlett quickly accepted.

The way a London newspaper told the story, however, the zoo superintendent had no idea that Barnum's agent was serious about the offer. But soon after the conversation, Barnum's check arrived at the zoo and the agent asked to take possession of the elephant. The newspaper account went on: "The cheque dazzles the secretary and the council. They look at it, they dream about it; they neglect to send it back: they keep it too long and then find out they have legally accepted the price placed upon poor Jumbo's head."

Of course, there had been more to the transaction than that. There was a signed contract between Barnum and the Royal Zoological Society, which stipulated that Jumbo "be taken as he stands," resulting, as we shall see, in complications.

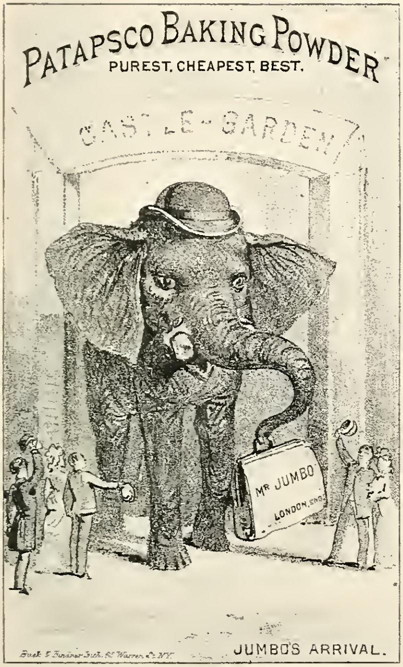
At any rate, within a day or two after Barnum's bank draft arrived in London on February 16, 1882, the news of Jumbo's sale became public knowledge and all hell broke loose. London went Jumbo-crazy. Hundreds of letters mourning the sale of the elephant poured into the newspapers. Children collected pennies to buy him back. Romantic Britishers protested that the sale would separate Jumbo from Alice, who they claimed was his "wife." Actually, according to the most reliable sources, the two were rather indifferent to one another, even during Jumbo's musth.

The London *Standard* compared the act of separating Jumbo from his British public to that of a southern slaveowner selling the members of a slave family separately at auction. "Surely, to tear this aged brute from a home to which he is attached, and from associates who have so markedly displayed their affection for him, is scarcely less cruel." In his autobiography, P.T. Barnum wrote that

> an excitement prevailed and increased throughout Great Britain, which, for a cause so comparatively trivial, has never had a parallel in any civilized country. The newspapers, from the London *Times* down, daily thundered anathemas against the sale, and their columns teemed with communications from statesmen, noblemen, and persons of distinction, including Queen Victoria and the Prince of Wales, advising that the bargain should be broken at all risk and promising that the money would be contributed by the British public to pay any damages which might be awarded. . . . I received scores of letters from ladies and children, beseeching me to let Jumbo remain and to name what damages I required and they should be paid.
>
> All England seemed to run mad about Jumbo. Pictures of Jumbo, the life of Jumbo, a pamphlet headed "Jumbo-Barnum" and all sorts of Jumbo stories and poetry, Jumbo hats, Jumbo collars, Jumbo cigars, Jumbo neckties, Jumbo fans and Jumbo polkas were sold by the tens of thousands in the stores and streets of London and other British cities.

"Meanwhile," Barnum went on, "the London correspondents of the leading American newspapers cabled columns upon the subject, describing the sentimental Jumbo craze which had seized upon Great Britain. These facts stirred up excitement in the United States and the American newspapers and scores of letters sent to me daily urged me not to give up Jumbo."

The drama reached its peak on February 22, when the editor of the London *Daily Telegraph*, Sir John Merry Le Sage, cabled Barnum: "Editor's compliments; all British children distressed at elephant's departure; hundreds of correspondents beg us to inquire on what terms you will kindly return Jumbo."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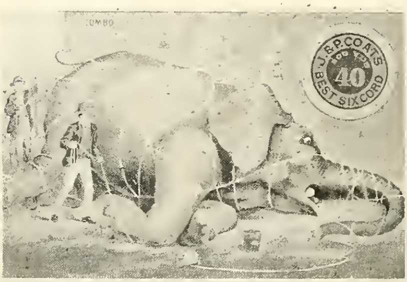
Barnum's reply arrived in London the next day and was printed in the paper:

> My compliments to Editor, *Daily Telegraph*, and British nation. Fifty-one millions of American citizens anxiously awaiting Jumbo's arrival. My forty years' invariable practice of exhibiting the best that money could procure makes Jumbo's presence here imperative. Hundred thousand pounds would be no inducement to cancel purchase.
>
> In December next, I visit Australia in person with Jumbo and my entire mammoth combination of seven shows, via California, thence through the Suez Canal. Following summer to London. I shall then exhibit in every prominent city in Great Britain. May afterwards return Jumbo to his old position in Royal Zoological Gardens. Wishing long life and prosperity to the British nation, the *Daily Telegraph* and Jumbo. I am the public's obedient servant, P.T. Barnum.

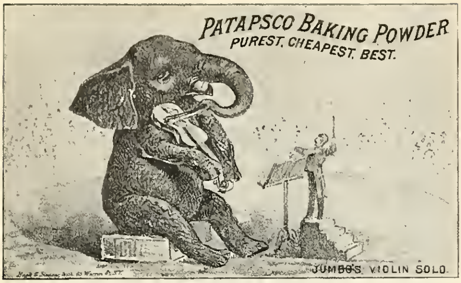
The paper printed the telegram and under it commented, "Jumbo's fate is sealed. His mighty heart will probably break with rage, shame and grief; and we may hear of him, like another Sampson [*sic*], playing the mischief with the Philistines who have led him into captivity and dying amid some scene of terrible wrath and ruin."

The fuss over Jumbo continued, however, and the newspapers printed many more letters and poems about the animal. One was a poem by Lord Winchelsea:



But since in England's fallen state,
She owns two things supremely great,
Jumbo and Gladstone (each we find
The most prodigious of their kind)
And one won't budge. Then, Barnum make
A fair exchange, for quiet's sake!
Take the Right Honorable and go!
He'll make the better raree show!
Leave Jumbo!

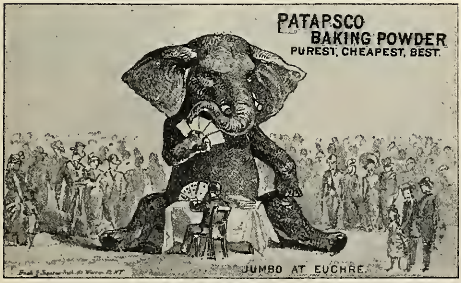
Eventually, the pressure was so great that the zoo trustees tried to break the contract through legal action. Berkeley Hill, a fellow of the Royal Zoological Society, asked the court for an injunction against the sale. He, together with the other trustees, held that the


PATAPSCO BAKING POWDER
PUREST, CHEAPEST, BEST.
JUMBO'S VIOLIN SOLO.

Society had no right to sell "any article valuable for the study of natural history." But the hearing, which lasted two days, revealed that the Society had sold animals before, in particular a gnu for $750. Consequently, the judge ruled that the sale was legal and binding.

Barnum soon discovered that it was one thing to own Jumbo but quite another to get him to the United States. And according to the contract, the zoo was not obliged to help.

To carry Jumbo across the Atlantic, Barnum had modified a steamer, the *Assyrian Monarch.* To quiet those concerned with the animal's comfort and well-being, he wrote that

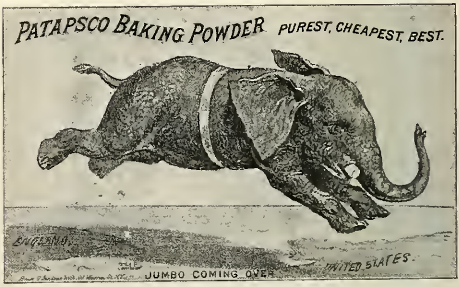

PATAPSCO
BAKING POWDER
PUREST, CHEAPEST, BEST.
JUMBO AT EUCHRE.

> the berth prepared for the elephant is down the second hatchway from the bows, where the pitching of the vessel will not be greatly felt. There is no room for him amidships, as the saloons and first-class cabins are there placed, and the after-decks are being fitted up for some 400 emigrants, mostly Jews from Russia, who are about to seek their better fortune in the land of the West. The elephant cage will stand upon the steerage deck; and it will rise through the hatch of the main-deck to the upper deck, where except in rough water, it will be open to light and air. The area assigned to it is about 20 feet by 15 feet and there will be a clear height of 18 feet. The animal will thus see and be seen by the people on three decks and will be in no want of company.

Barnum did not mention that the elephant would displace about 200 emigrants on the trip.

The day before Jumbo was to leave the zoo, he received a large box of poisoned biscuits from an anonymous source. It was a sadistic gesture, perhaps suggesting a desire that Jumbo remain in England—dead or alive. Jumbo took one sniff, however, and turned away from the treat.

On the appointed day of departure, Jumbo's keeper, Matthew Scott, led him out of the zoo and started him on the nine-mile walk to the Milwall docks on the Thames. But when the zoo gate closed behind him, the huge animal stopped short, trumpeted, and lay down in the street. To some of the crowd that had gathered to wish him farewell, Jumbo's trumpeting sounded like cries of grief at being forced to leave his home and Alice. Their hearts went out to him.


PATAPSCO BAKING POWDER PUREST, CHEAPEST, BEST.
ENGLAND.
UNITED STATES.
JUMBO COMING OVER.

Barnum later wrote, "My agent, dismayed, cabled me, 'Jumbo has laid down in the street and won't get up. What shall we do?'

"I replied, 'Let him lie there a week if he wants to. It is the best advertisement in the world.' "

But 24 hours later, the zoo gates were reopened and Jumbo immediately lurched to his feet and lumbered

We'd like you to know about Exxon Corporation.
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Exxon explorers search for oil and gas around the world—the odds are usually against them.

Drilling a single exploratory well can take more than a year. It can mean moving hundreds of tons of equipment to the high Arctic or deep into the desert.

Yet, more often than not, it is a failure.

Nevertheless, the search goes on—and for good reason—to help make sure there will be enough energy for everyone who needs it—now and in the future.

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In the U.S. the Exxon explorers search from coast to coast and beyond, far out onto the continental shelf. They are drilling on every continent, with recent successes in Alaska, Australia, Canada, Florida, and in the North Sea off Scotland.

As a result of these efforts Exxon has over 20,000 oil- and gas-producing wells in the United States and another 7,000 abroad.

EXXON

At any given time Exxon is moving 4.5 billion gallons of oil, in tankers, barges, pipelines and trucks.

As you read this, the oil is moving. It is moving in tankers across the oceans of the world and up and down the coasts of every continent. The Exxon tanker fleet is among the world's largest. Steaming along at a sedate 15 to 20 miles an hour, a single Exxon tanker can deliver 20 million gallons of crude oil from Texas to a New Jersey refinery in eight days.

Pipelines silently move oil, natural gas, gasoline, jet fuel and other products around the country. Exxon and other companies often share these lines.

Oil products travel the inland waterways—the Mississippi, the Ohio, the Hudson—by barge. One tug, the *Exxon Tennessee*, can push eight barges at a time, loaded with 750,000 gallons of oil, all the way from Louisiana up to Pittsburgh in 14 days. Slow but steady.

Where the tankers, pipelines and barges can't go, the tank truck takes over, delivering to homes and service stations.

It's a complex and astonishingly efficient transportation system that keeps the oil moving from our wells to our customers.

Many of the world's refineries use at least one of the refining processes developed by Exxon.

Stated as simply as possible, the job of an oil refinery is to transform crude oils into products that are useable: gasolines, heating oils, diesel and jet fuels, asphalts, chemicals and hundreds more. Exxon has pioneered many of the processes with which the complex needs of modern living can be met from nature's raw materials.

In the United States, Exxon has five refineries. Its affiliates abroad have another 60.

Today it's common to relate petroleum and chemicals, but before 1920 it was practically unheard of.

It was in that year that an Exxon refinery produced the first commercial "petrochemical."

From this beginning, Exxon Chemical Company has grown into a business with 60 plants in 24 countries. Its products are used in everything from plastics to cosmetics. Today, petroleum is the source of 80 per cent of the raw materials of modern chemistry.

Exxon is making a determined effort to minimize pollution, both from its operations and its products.

Simply running the business of oil efficiently these days is not good enough. That's why Exxon is investing some $200,000,000 every year to remove sulfur, to clean up water and to do a lot of other things to help the environment. Here are just a few.

Because oilmen, even old-timers, rarely see a well out of control, Exxon has established a special school in "blowout" prevention techniques in Texas. It teaches drillers what to do if and when they are ever confronted with one of these rare crises.

Tanker captains receive unique training at a facility Exxon built in Grenoble, France. Here, in realistically scaled model tankers, they learn the special skills they'll need to handle and berth the largest supertankers afloat.

Exxon has been instrumental in setting up many organizations dedicated to rapid and effective cleanup in the event of oil spills. Each of our U.S. refineries has a full-time staff of environmental specialists.

All of this is part of a continuing battle to get ourselves and our industry in harmony with the environment.

Exxon research scientists average a patent a day every working day.

Exxon scientists and engineers are involved in about 1000 different projects at any given time.

These projects could range from the development of offshore mooring devices for very large tankers to the study of unique methods for burning high-sulfur fuels in order to create as little pollution as possible. They cover everything from waste water treatment to new engineering for modern refinery processes.

Exxon researchers are developing better ways to make synthetic rubber, and better ways to extract more oil from underground reservoirs.

With an overall research program that is costing $100,000,000 a year, every day Exxon is coming up with something that, in one way or another, helps you.

And this is helping all over the world because Exxon research is multinational. It focuses the talent of more than 5,000 scientists and engineers in seven countries on solving the problems of our company and meeting the needs of our customers.

If you're like most people, the only time you come face to face with Exxon is at a service station.

EXXON EXTRA

The chances of coming face to face with an Exxon service station are pretty good—because there are 25,000 of them from coast to coast.

Over the years you've probably come to know your local Exxon dealer and the fine products and services he can offer you.

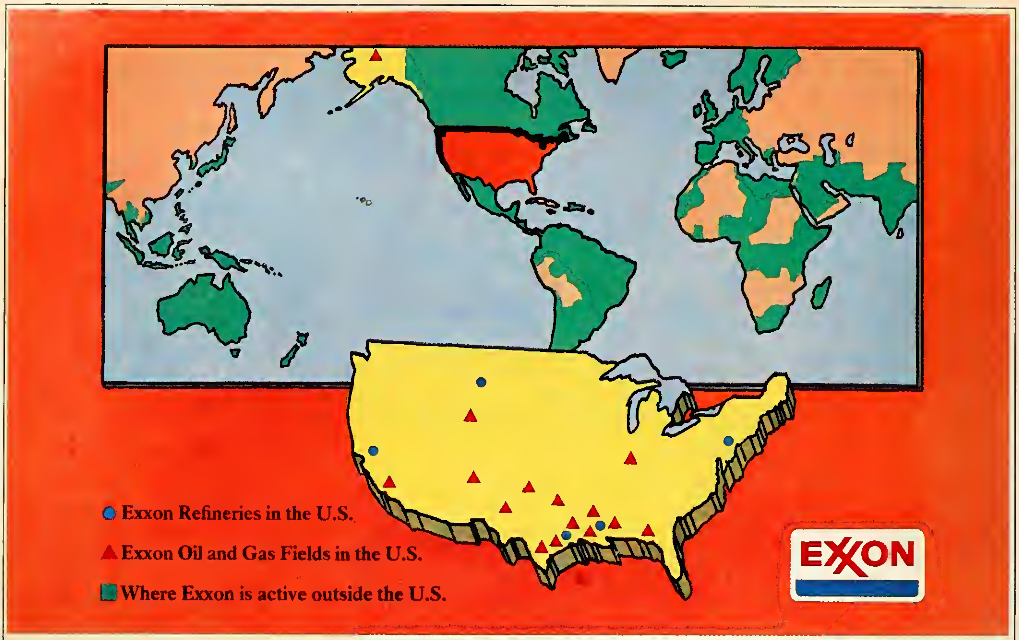
Perhaps you have also learned to depend on our touring service or road maps—Exxon was the first oil company to offer road maps, way back in 1922.

If you've had some trouble with your car you might have driven it into one of the many Exxon Car Care Centers where the problems were diagnosed rapidly and repaired efficiently.

Exxon Marinas, Travel Parks and Avitats catering to the needs of boaters, campers and flyers can be found in many parts of the country, and of course, your Exxon credit card can be used at all of them.

Abroad, you can buy equally fine products through our affiliates in more than 100 countries.

EXXON


● Exxon Refineries in the U.S.
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EXXON

A corporation should be a "corporate citizen" as well.

The people of Exxon Corporation have made sure that the company is committed to goals that go beyond the primary responsibilities of conducting their business efficiently. There is also a commitment to society, and that commitment is an integral part of the business of Exxon.

The Exxon Education Foundation, for example, has a seventeen-year history of financial support to higher education—in fact, it has contributed over 34 million dollars to date.

And for nearly as long, Exxon has supported fine arts through competitions around the world, educational experiments like Harlem Prep, and excellence in television programming like *An Age of Kings* and *Play of the Week* and, more recently, *Vibrations*.

Beyond this are the individual activities of our many employees working, often with Exxon support, in community projects as varied and numerous as the skills they offer.

We'd like you to know Exxon.

We hope these pages have told you something about Exxon Corporation—who we are, what we do and where we work.

We are U.S.-based with many affiliates abroad. There are, in fact, 143,000 Exxon employees around the world. Our primary task is finding, producing, transporting, refining and selling oil and natural gas to millions of customers.

In the United States, there are 40,000 of us; most of us work for Exxon Company, U.S.A., in itself one of America's leading oil and gas enterprises. In recent months Exxon Company, U.S.A. has carried out the change to Exxon that you've seen at your service station.

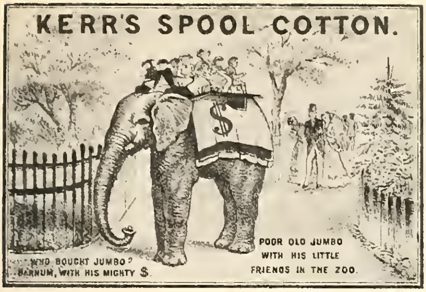
An important part of our worldwide business is chemicals. This is guided by Exxon Chemical Company. U.S. chemical operations are conducted by Exxon Chemical Company U.S.A.

We are also companies that do research and engineering, international exploration, development of non-petroleum energy sources, and land development. This should give you an idea of our scope.

Although the name of Exxon Corporation is new, we realize that our reputation will continue to depend upon the quality of our products, the service we offer and the way we conduct ourselves.

J. K. Jamieson
Chairman,
Exxon Corporation

C. C. Garvin, Jr.
President,
Exxon Corporation


KERR'S SPOOL COTTON.
$
WHO BOUGHT JUMBO? BARNUM, WITH HIS MIGHTY $.
POOR OLD JUMBO WITH HIS LITTLE FRIENDS IN THE ZOO.

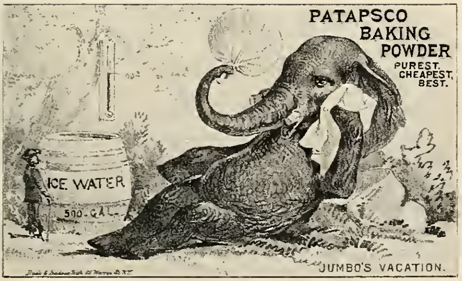
back inside. Barnum's agents then set about figuring how to get the beast to the docks by some means other than his own power.

What they came up with was a cage on wheels with doors at each end. One night they placed this contraption at the door of Jumbo's stall, sinking its wheels into the ground so that its floor was level with that of the elephant house. After some initial suspicion, Jumbo walked through the tunnellike cage to take his daily stroll outdoors.

Jumbo soon became accustomed to the new cage, and one day as he slowly walked through it, Barnum's agents slammed both doors shut. Jumbo tried to smash through the cage, hurling his body first against one wall, then the other. He stuck his trunk through the bars and tried to pull them apart.

Scott, whom Barnum had hired to care for Jumbo in America, tried to calm him while Barnum's agents brought up a 40-horse team. It was going to be quite a haul, since, together, the elephant and the cage weighed 12 tons.

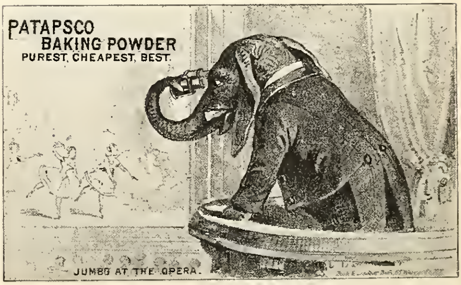
Three hours after it started out, the cage arrived at dockside, having passed along a crowd-lined route. A steam crane lifted it onto a waiting barge, which moved out to meet the *Assyrian Monarch*. There, a block and tackle lifted the cage—and the elephant within—into the section that had been reserved for it.


PATAPSCO BAKING POWDER
PUREST, CHEAPEST, BEST.
ICE WATER
500 GAL.
JUMBO'S VACATION.

"The Society for the Prevention of Cruelty to Animals hovered over Jumbo to the last," Barnum wrote, "and titled ladies and little children brought to the ship baskets of dainties for Jumbo's consumption during the voyage."

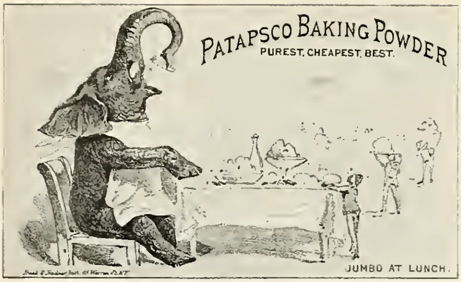
Fifteen days later, after a rough crossing during which the elephant was sick for at least two days, the *Assyrian Monarch* arrived in New York City on Easter Sunday, April 9, 1882. A team of horses pulled Jumbo's cage up Broadway to Madison Square Garden, while thousands of New Yorkers watched in awe.

Once on exhibit, "he created such a sensation," wrote Barnum, "that in the next two weeks, the receipts in excess of the usual amount more than repaid us the $30,000 his purchase and removal had cost us." In Jumbo's first 31-week season, Americans spent $1,750,000 to see him.


PATAPSCO BAKING POWDER
PUREST, CHEAPEST, BEST.
JUMBO AT THE OPERA.

To be fair, Jumbo wasn't the only reason people flocked to the show. Barnum and Bailey had assembled an array of outstanding attractions, including, at one time or another, General Tom Thumb, the midget; an eight-foot Chinese giant named Chang Wu Sing; the two "wild men" of Borneo (actually Hiram and Barney Davis of Long Island); Chang and Eng, the original Siamese twins, who between them had 21 children; and the Fiji Mermaid (actually the embalmed upper half of a monkey joined to the lower half of a fish).

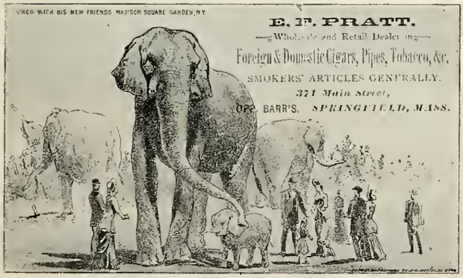
But Jumbo was the circus' greatest attraction. Barnum advertised him as "huger in his proportions than the monster which Ptolemaeus states was brought by Caesar to Britain in 54 B.C. and terrified the inhabitants greatly and probably more colossal than the


PATAPSCO BAKING POWDER
PUREST, CHEAPEST, BEST.
JUMBO AT LUNCH.

'elephant of enormous size' which was presented by the King of France [Louis IX] to Henry III of England in 1255."

"Jumbo," Barnum said, "is today the largest known animal that walks the earth and many well-informed persons believe he is as large as the mastodon of bygone ages."

For once in his life, perhaps, Barnum wasn't exaggerating, at least not much. Contemporary sources tend to agree that Jumbo was the largest elephant ever seen up to that time in any zoo or circus. Barnum's figures for Jumbo's height and weight are hard to prove, however, since he never allowed his prize to be carefully measured by any disinterested parties.


JUMBO WITH HIS NEW FRIENDS MADISON SQUARE GARDEN, N.Y.
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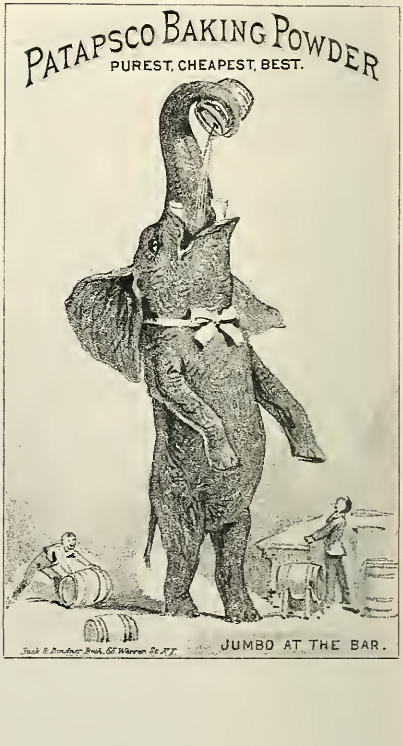
OPP. BARR'S, SPRINGFIELD, MASS.

Measuring the height of an elephant is no easy trick. Ivan T. Sanderson in his book *Dynasty of Abu* suggests that the only way to accurately measure the height of an elephant is to "have the animal stand on firm ground in a doorway, lower a bar with a spirit-level on it till it just rests on the elephant's back, mark where the beam touches the door uprights on either side, then measure the distance from these marks to the floor."

According to Sanderson, there is one other way to estimate an elephant's height—by measuring the circumference of his forefoot and multiplying by two in the case of Asiatic elephants, or by two plus 10 percent in the case of African bush loxodonts, the elephant genus to which Jumbo belonged.

As it happens, we do have an accurate measurement of Jumbo's forefoot. During the Jumbo excitement, Joe Howard, the London correspondent for the Philadelphia *Times* wrote that Jumbo's feet were 20 inches in diameter, too large for an old-fashioned ottoman. That works out to 62.8 inches in circumference, or, using Sanderson's formula, 11 feet 5 inches in height.


PATAPSCO BAKING POWDER
PUREST, CHEAPEST, BEST.
JUMBO AT THE BAR.

We shall probably never know Jumbo's exact height. It is impossible, Sanderson says, to accurately measure the height of dead elephants, since the weight of the body pushes the supple shoulder blades upward at the spot of greatest height in an African elephant, the shoulders. Asiatic elephants are tallest approximately amidships, since, unlike the African variety, they are slightly humpbacked.

Although a very large elephant, Jumbo was not the largest ever seen. In the early 1900s, Major Powell-Cotton shot one in Africa that, by various measurements made after its death, was thought to be 12 feet 6 inches high at the shoulder. Then, in 1955 J. J. Fenykovi shot an elephant in the Cuando River region of Southwest Africa that, after its death, measured 13 feet 2 inches at the shoulder and weighed 12 tons. Later estimates of the elephant's weight, however, place it at 8 tons. That specimen was given to the Smithsonian Institution, where it went on public view in 1959. These are both postmortem measurements, but, even given some inaccuracy, both seem to surpass Jumbo in size. In 1882, however, when Barnum claimed that Jumbo was the largest elephant "in or out of captivity," he had every reason to believe he was right.

To provide Jumbo with company, as well as a size contrast, Barnum often displayed him with a young, small elephant named Tom Thumb. After a while, the two elephants became friends, and even traveled together in "Jumbo's Palace Car" in the circus train.

Every day, Jumbo ate 200 pounds of hay, 15 loaves of bread, and an assortment of oats, biscuits, onions, and fruits, or so Barnum claimed. He also said the elephant drank five pails of water, a quart of whiskey, and an occasional stein of beer.

Although Jumbo performed no tricks, he earned his keep by strolling around the rings, accompanied by his keeper and a gaggle of tumbling clowns. He crisscrossed America, delighting millions of children here, but he never went on the European tour that Barnum had described in his cable to the *Daily Telegraph.*

On September 14, 1885, after a performance at St. Thomas, Ontario, Jumbo died in a tragic accident. There are various descriptions of how the sudden tragedy occurred, but the following account seems to be the most reliable. Most of the menagerie had already been loaded onto rail cars and the crew was striking the tents, when Matthew Scott led Jumbo and Tom Thumb over an apparently unused railroad spur. About 500 yards ahead, the spur went around a sharp bend and joined the Grand Trunk Railway. As they were crossing the track, a freight train came round the bend and bore down on them. Scott shouted at Jumbo and yanked his chain, but the elephant seemed paralyzed with fear at the sight of the onrushing locomotive and its glaring headlight.

The train hit Tom Thumb first, tossing him aside and breaking his left rear leg. Then it plowed into Jumbo almost head on. There was a tremendous crash and Jumbo was knocked to the ground, his skull smashed. According to eyewitnesses, before he died the elephant waved his trunk once at his keeper, who had jumped aside at the last instant.

Nearby, the locomotive and two cars lay derailed; the engineer was dead. Tom Thumb eventually recovered and returned to the circus ring, but died several years later, apparently from apoplexy.

"The loss is tremendous," Barnum told newspaper reporters afterward. "But such a trifle never disturbs my nerves. Long ago, I learned that to those who mean right and try to do right, there are no such things as real misfortunes."

Barnum used Jumbo's death to display his showmanship once again. He had the carcass hauled off to Ward's Natural Science Establishment in Rochester, New York, where Carl Akeley and Prof. Henry Ward mounted it on a hardwood frame. The staff also studied Jumbo's teeth and bones and decided that, if he had lived, he might have grown as much as 15 inches more. In his belly they found many English pennies, sixpences, and threepenny bits, plus a policeman's whistle and a ring of keys.

Jumbo was killed by a freight train in Ontario on September 14, 1885.

There was no way Barnum could replace Jumbo, but he tried to use him even though he was dead. His agents went back to the Royal Zoological Gardens. This time, they bought Alice. For several months, Barnum exhibited Alice beside the stuffed hide of Jumbo, as his "widow." But the public showed little interest.

Finally, Barnum presented Jumbo's skeleton to The American Museum of Natural History (where it will soon be on display in the Biology of Mammals Hall); the mounted hide was given to the Barnum Museum at Tufts University, in Medford, Massachusetts.

Jumbo can no longer be seen meandering around the circus ring, gobbling up candy and peanuts, trumpeting and waving his trunk. But Jumbo, the elephant wonder that captured the imagination of two nations, gave us his name as a synonym for *huge*, and in this way he has outlasted all of Barnum's other wonders. ■

Secrets of the Coelacanth

Once known only as a fossil, a rare Indian Ocean fish has begun to emerge from geologic and oceanic darkness. But to learn more about it, we may have to go down to where it lives

by Keith S. Thomson

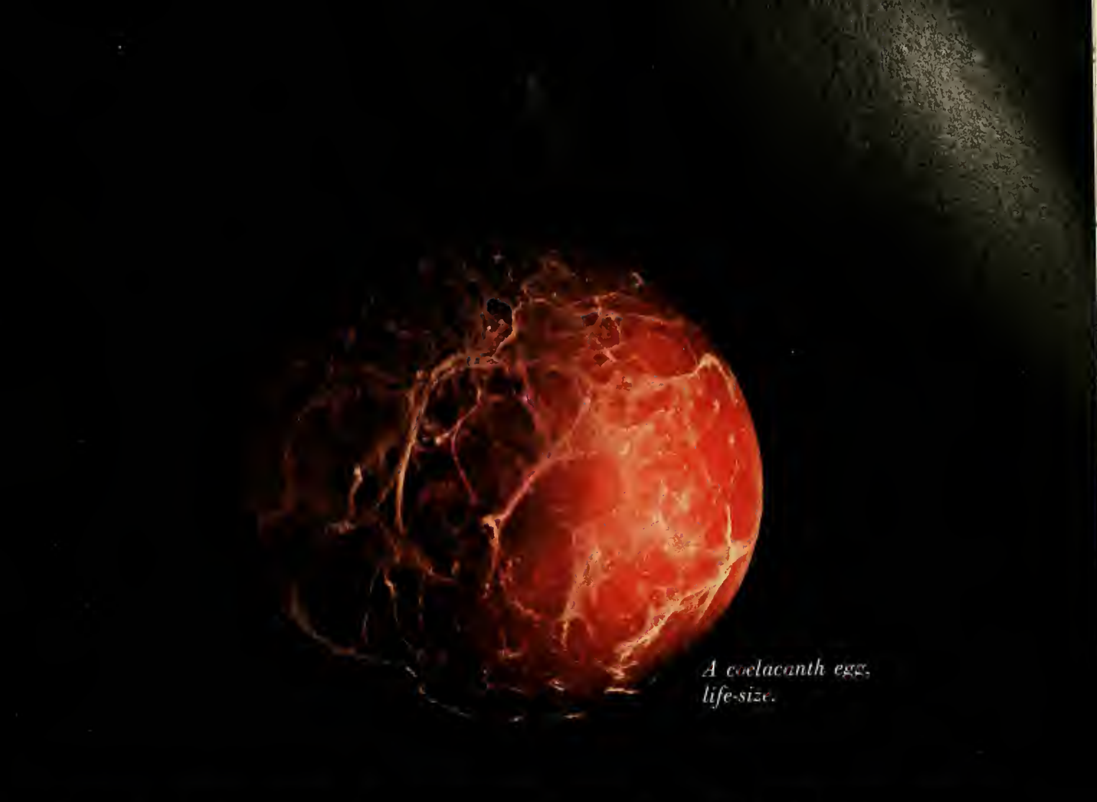
LIVE COELACANTH CAUGHT THIS AM. MOVIES DISSECTION OK. STOPOVER PARIS. HOME AROUND THE FIRST.

This cable, sent a year ago from the Comoro Islands by Robert Griffith of Yale, marked the latest success in research on the coelacanth, the fish that scientists once thought had been extinct for millions of years. For the first time a coelacanth had been caught, kept alive for several hours, and studied in detail. Precious tiny cargoes of frozen and chemically preserved tissues have since been sent to scientists all over the world, and research on the coelacanth is now proceeding at an intense level. This fish, always so enigmatic, so difficult to catch and study, is slowly yielding up its secrets. But there is still much to be discovered and the direction of future research is not clear.

The first coelacanth known to science was a small fossil wrongly described as a bowfin in 1822. Thereafter, several types of coelacanth were correctly recognized, and in 1855 Louis Agassiz gave the group its formal name Coelacanthini, after the Carboniferous genus *Coelacanthus* ("hollow spine"). At present, there are 28 known fossil coelacanth genera, ranging in age from the Early Devonian to the Late Cretaceous. Since no fossil has been found of more recent age, it was thought that the group became extinct 70 million years ago, along with most other fauna of the Age of Reptiles.

Coelacanths have always interested paleontologists because of their morphological similarity and phylogenetically close relationship to the lungfish and to the Rhipidistia, a Paleozoic fossil order. Together these form the "lobe-finned fishes," and by the turn of the century it was clear that it must have been from within this group (actually from the extinct Rhipidistia) that the first amphibians evolved in Devonian times. For all their similarity to the ancestors of the tetrapods, however, it was clear that the coelacanths were a largely marine group of fishes. To the student of tetrapod origins, the air-breathing lungfish, with three living tropical freshwater genera available for study, were always of more immediate concern in the search for analogies with the Devonian Rhipidistia and amphibian origins.

But then in December, 1938, a living coelacanth was trawled from the bay of the Chalumna River, near East London, South Africa. It was an event of spectacular significance, worthy of the *Lost World* of Sir Arthur Conan Doyle. The late Prof. J.L.B. Smith of Grahamstown University identified the fish and published a scientific description of it, although all that remained when he saw it was the skin and part of the skull. Smith named it *Latimeria chalumnae*, after Miss Courtenay Latimer of the East London Museum—to whom the fish was first taken and who called in Smith—and after the place of capture.



A coelacanth egg, life-size.

For fourteen years the search for further specimens continued, until in December, 1952, a second specimen was brought to Smith's notice. This one had been caught on the island of Anjouan in the small Comoroan group to the northwest of Madagascar. A local fisherman had recognized it from a poster, which Smith had distributed widely up and down the east coast of Africa. He claimed the reward, and Smith, in a plane loaned to him by the South African prime minister, flew to the Comoros in order to collect the specimen.

The Comoro Islands are French territory, and since 1952 intensive research into the coelacanth, principally in terms of descriptive morphology, has been conducted at the Muséum National d'Histoire Naturelle in Paris. By 1960 some 40 to 50 specimens had been caught, preserved in formalin, and shipped to Paris for study. A long series of notices on the structure of *Latimeria*, together with the first two volumes of a planned comprehensive anatomy, has been published in Paris and elsewhere since 1953.

Regrettably, of all the specimens captured before 1972, only one lived long enough to be observed by scientists. In 1955 a specimen was held in a submerged dinghy for some hours before it succumbed. About 1962, further specimens caught in the Comoros were offered for sale to museums around the world, and formalin-preserved specimens have now been distributed to Britain, the Soviet Union, North America, and Australia. From this worldwide effort a clear picture of the fish's anatomy has emerged.

Latimeria chalumnae is a large fish with a mouthful of sharp teeth. It reaches a length of six feet and a weight of 175 pounds. Its scales and fin rays are armored with many short, sharp spines. Its color is a muddy gray-blue, which rapidly becomes more brown after death. The eye is clear, but in specimens brought up from the depths it becomes cloudy because of pressure effects on the crystalline structure of the lens. The eye reflects a yellow color from a membrane over the retina. The skull has a curious intracranial joint, and the paired fins are large, lobed, and extremely mobile, with their own internal skeleton and muscle system.

There are no true lungs, but the fish has a fat-filled swim bladder evidently derived from the paired lungs of a distant ancestor. Thus, the fish cannot breathe air. There is no internal nostril. The stomach has a thick muscular wall, which often results in the contents being voided during capture, thus depriving us of information about the fish's diet. The rest of the internal organs need no mention here except for the reproductive system. Two gravid females have been caught, including one in 1972 that contained 19 eggs of enormous size, more than 4 inches across. They lack any protective shell or membrane.

Apart from the first specimen,

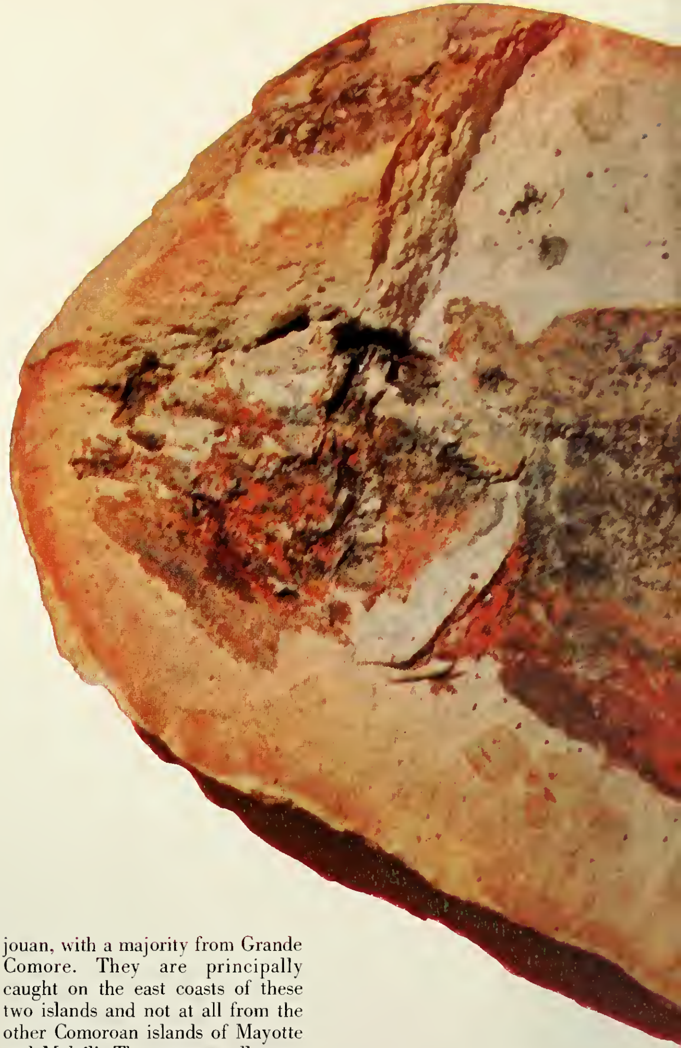
which came from off the coast of South Africa, *Latimeria chalumnae* has only been caught off the Comoro Islands and in fact from only two of these—Anjouan and Grande Comore. They have been caught at depths from 100 to about 800 meters (but mostly above 400 meters). More than 70 specimens have been taken at a capture rate of two to four per year.

To this bare catalog we could add a great mass of detailed anatomy, but there is a notable lack of information about the ecology and general way of life of these fish. This last affects not only our attempts to interpret what we have so far learned about the fish but also questions regarding how rare the fish is and how it has survived.

One reason for our long ignorance about the mere existence of living coelacanths and our continued inability to learn their secrets is the remoteness of the Comoro Islands. Set in the Mozambique Channel, the *archipel des parfums* consists of four volcanic islands with small fringing reefs. Beyond the reef, the underwater profile is very steep, plunging down some 2,000 to 3,000 meters. The geologic history and submarine topography of these islands may provide part of the explanation of how the coelacanth survived from prehistoric times. Two hundred million years ago coelacanths were a not uncommon part of shallow sea faunas worldwide. Is it a coincidence that some of the best-known fossil coelacanth specimens come from the Triassic beds of nearby Madagascar?

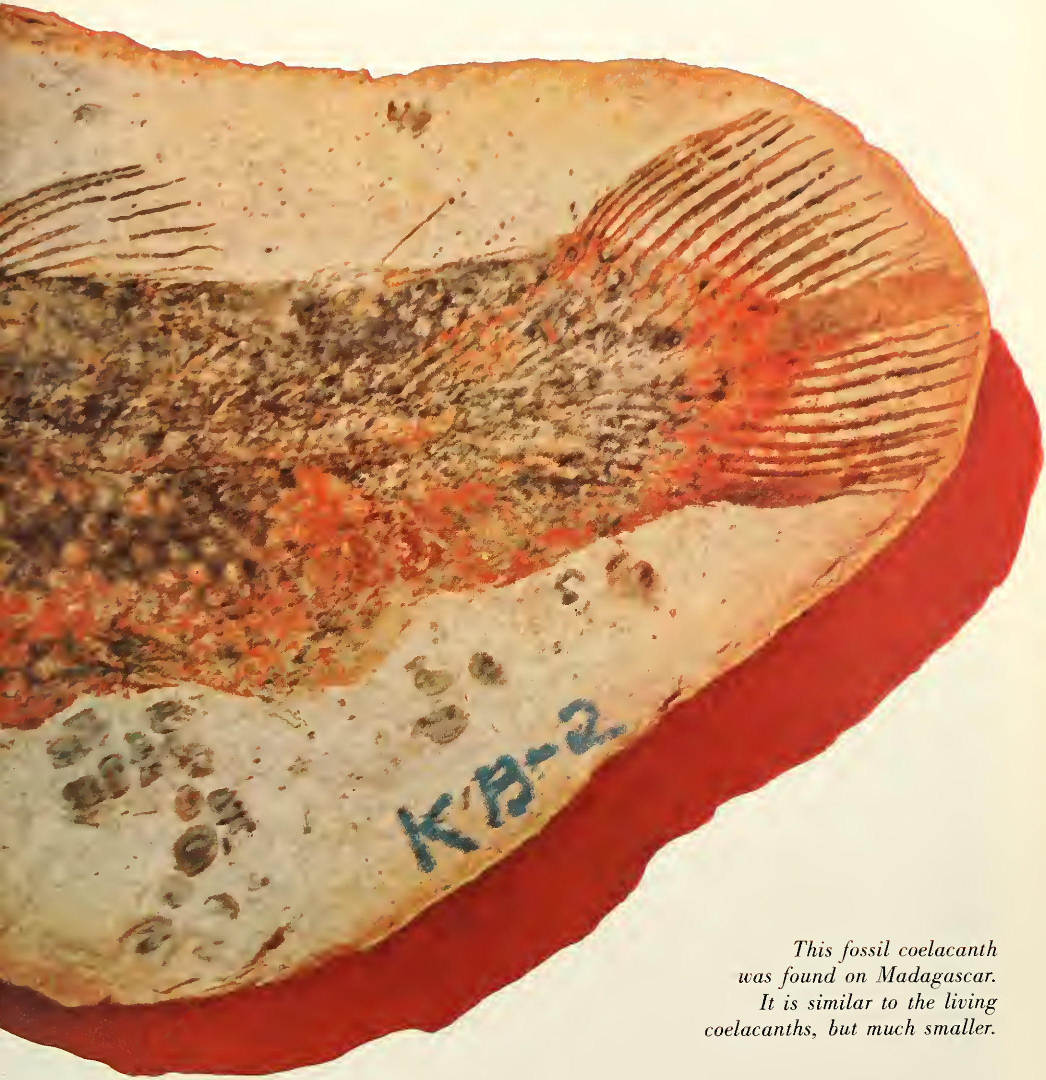
There seems to be little to distinguish the Comoros from other islands in the western Indian Ocean, such as the Aldabra series. An expedition sent by the Royal Society of 1969 to some of these other islands showed that the fish populations on their deep underwater slopes are almost exactly like those of the Comoro Islands (although no coelacanths have been caught there).

Examination of the available statistics on catches shows that, apart from the first South African specimen, all coelacanths have been caught off Grande Comore and Anjouan, with a majority from Grande Comore. They are principally caught on the east coasts of these two islands and not at all from the other Comoroan islands of Mayotte and Mohéli. The captures all come in the early hours of morning darkness. The majority are caught from January to March, but a large number are taken during the rest of the year. To interpret these data, we must know much more about the nature of the fishing effort. One may be reasonably sure, for instance, that the reason for their apparent absence from Mayotte and Mohéli is the lack of extensive fisheries there. Could this also explain their apparent absence from all the other islands of the western Indian Ocean?



The Comoroan fishermen work alone in outrigger canoes hollowed from mango logs. They fish with a single hook on a vertical line sent down to the bottom by a chunk of rock secured by a slipknot, which is then released. They fish at, or very near, the bottom, normally in depths of up to 400 meters. Presumably this is the deepest that can conveniently be worked in this fashion. Curiously, the months from January to March present the very worst weather in the Comoros.

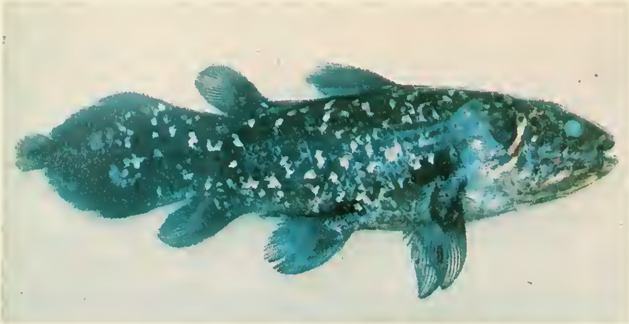
One needs to ask, therefore, why



This fossil coelacanth was found on Madagascar. It is similar to the living coelacanths, but much smaller.

they bother to fish at this time, at night, and at these depths. The answer is that they are not normally seeking the coelacanth itself, but rather food fishes, especially the oilfish, *Ruvettus pretiosus*, which is relatively abundant at these depths around the islands, reefs, and banks in the western Indian Ocean. In the process they catch coelacanths, apparently largely by accident. Now when they are asked to go after a coelacanth, they obviously go to where they have previously caught them—the oilfish grounds. Thus, to put an extreme interpretation on the catch data, we might say that they present the coincidence of oilfish and *Latimeria* distribution at the season when oilfish are sought. This may actually be a bit strong, but at least it seems clear that the catch data reflect only the fishing effort and that fishing is not directed principally toward the coelacanth itself.

Given this unsatisfactory information, what can we say about the distribution and numbers of the fish? The sex ratio in the catch is



The clouded eye shows that this coelacanth, caught near the village of Iconi, is near death. Below, a fisherman paddles his outrigger pirogue off the island of Grand Comore. Only local fishermen have caught coelacanths; prolonged efforts by visiting scientists have been unsuccessful to date.

approximately 25 males to every 20 females. The size range has remained more or less constant, and no fish of less than 34 inches (estimated to be at least four years old) has been taken. This suggests that the catch rate (steady for nearly 20 years) has not significantly depleted the stocks. It seems likely that there are coelacanths around the other Comoroan islands that have not been taken at all. At this point, to develop an interpretation, it is necessary to turn back to the evidence from the dead fish.

Latimeria does not seem to be an open-water fish. The heavily armored surfaces and specialized lobe fins, as well as the nature of the other fins, suggest constant association with a hard substrate. While the caudal fin is a powerful structure, it is obviously only adapted for short, rapid bursts of swimming. The paired fins and the second dorsal and anal fins are adapted to slow, sculling movements by which the fish presumably moves along or near the bottom, pushing off from hard objects with the paired fins, waiting for prey to appear, and then taking it in a quick lunge.

The possibility is strong that coelacanths engage in a nocturnal migration toward the surface and that by day they lie at greater depths.

The eye is adapted only to low light intensity, the properties of the visual pigment comparing best with those of fishes known to live in deeper waters. The few stomach contents recorded include lantern fishes, which are known to be vertical migrators.

The fats in the swim bladder, and dispersed widely in the oily tissues of the coelacanth, contain many very light wax esters and presumably are an adaptation for giving neutral buoyancy. There are indications, its color, for example, that *Latimeria* is not a truly deep-sea fish. We might reconstruct, therefore, that *Latimeria* is a fish that lives a relatively sedentary existence near the bottom. At night it may come toward the surface to follow prey species, and migrate back down the submarine slopes of the islands during the day. If this is correct, then apart from detailed ecological preferences that we do not know of, the species could be widely dispersed within the area immediately around the Comoros. But to move beyond this region, the fish would probably have to swim in open water, away from the bottom, which may explain its restricted distribution. As to population size, we cannot guess, but common sense tells us that to be safe we should avoid a catch rate higher than the present one.

There is a definite limit to what can be learned from museum specimens chemically preserved in formalin. Therefore in 1966 an attempt was made by the Comoroan authorities to freeze and ship a fresh specimen to Yale. The venture succeeded beyond all our hopes, and on Memorial Day, 1966, a group of scientists gathered around a laboratory table and made the first detailed examination of a fresh coelacanth. Within a few weeks it was clear that surprising results would be obtained. Prof. Grace E. Pickford of Yale discovered that *Latimeria*, unlike all other known bony fishes, balances the osmotic pressure of its blood by a mechanism of urea retention generally identical to that used by the elasmobranch fishes (sharks and rays). Prof. G. W. Brown and Dr. Susan Brown discovered that the liver contains all the enzymes of the ornithine cycle—the biochemical process by which the urea is produced. I found that, contrary to widely held opinion, the skull of the coelacanth, which is characterized by a set of joints separating the braincase into two parts, is movable through some eight to ten degrees, producing one of the most curious mechanisms of jaw movement known in vertebrates. Since this mechanism is also found in the fossil Rhipidistia, it was most important to discover what happens in a live specimen.

From the Yale coelacanth, "fresh" specimens of a wide variety of tissues were rushed to biologists at every hand, all of whom wanted a chance to compare the biology of this "primitive" fish with what is known of other living fishes. Interest in the biology of ancient fishes and the origin of tetrapods rose to a new high. But with the study came problems. Obviously more material was needed, the history of which was known exactly. The study of frozen tissues pointed up a whole series of exciting problems (what, for example, was the visual pigment of the eye like?) that could only be answered in one way—we had to get our hands on a completely fresh specimen.

In January, 1972, a joint expedition of the Royal Society (London), the Muséum National d'Histoire Naturelle in Paris, and the National Academy of Sciences (sponsored by the National Geographic Society) arrived in the Comoros. The expedition had been planned for nearly five years. Biologists all over the world had been canvassed and a complete set of protocols for optimum preservation of tissues from a coelacanth had been set up. Every effort would be made, should a specimen be caught, to keep it alive as long as possible in order to make observations on the living fish. The party planned to use every possible fishing method. They had their own gear, to be used from a launch, and also intended to mobilize the local fishermen.

In the end it was, as ever, only the local fishermen who succeeded. In fact, the entire success of the expedition resulted from the labors of the Comoroan fishermen, who went out night after night to help the visitors in their search for the *gombessa ’jomole.*

The expedition was immediately successful. On the night of January 6, before the American contingent had even arrived, the British and French got the news that a large specimen had been caught off Anjouan. But by the time the scientists made the 70-mile journey from Moroni, the fish was dead. Much useful information, however, including priceless tissue samples, was obtained. The specimen was only the second mature female to have been caught and it contained 19 enormous eggs, perhaps the largest fish eggs ever seen.

Bad weather intervened, but the fishermen were persuaded to redouble their nightly work. By mid-March a familiar pattern had set in: rainy days, sunny days, lots of fishing, no coelacanths. Only Robert Griffith of Yale and Adam Locket of the Institute of Ophthalmology in London remained when at 3:00 A.M. on March 22, Mohammed Ali Chabane, the headman of the village of Iconi on Grande Comore, woke them up—a live coelacanth had been caught at Iconi, 12 miles away.

The fish had been caught by Madi Youssouf Kaar and brought to shore, where it was transferred to a submerged wire mesh cage. Griffith and Locket observed it by artificial light until daybreak, making detailed notes on its color and behavior, especially the use of the fins. They then transferred the fish to a large tank where they made a motion picture record of it, as well as the photograph shown on page 62. The reconstruction of the swimming of coelacanths is based largely on their observations.

One cannot be sure why coelacanths die when brought to the surface: it must be a combination of decompression effects, temperature change, and general shock. Lacking specialized equipment to keep it alive (for this was only a pilot expedition), the two scientists prepared to dissect their prize. The specimen, an immature female only 33 inches long, had been caught only 600 meters from shore at a depth of about 100 meters. It lived for a total of seven hours after capture, most of the time confined under difficult conditions.

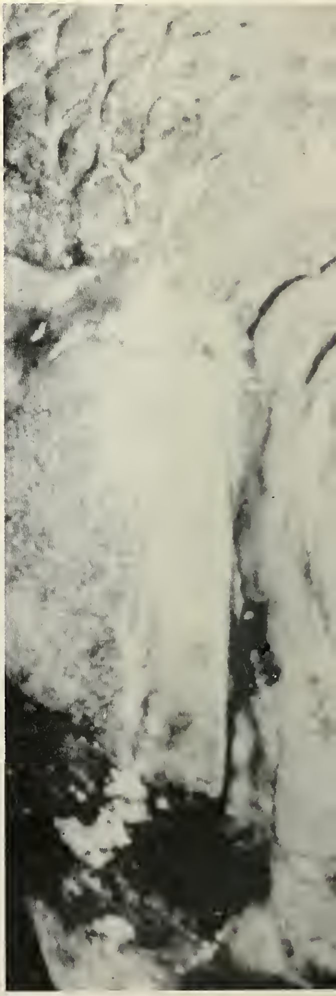
The 1972 expedition finally established that closely supervised intensive fishing by the local fishermen can confidently be expected to produce a coelacanth if one is prepared to wait a couple of months. It confirmed that specimens can be kept alive for a while and raises the hope that more elaborate methods might succeed in keeping one alive longer. A great deal of research material was gained, and the osmotic physiology, blood, eye, reproductive system, bone and cartilage, and many aspects of the basic biochemistry of the coelacanth are now under scrutiny. Observation of the live fish showed something of the swimming and respiratory system. Now, what should be the pattern for future research?

Among the results gained by the expedition was the capture of a mature female. The nature of the eggs indicates that some kind of special breeding behavior occurs in the coelacanth. It may be ovoviparous (a view Dr. Griffith and I favor) or, at the very least, if the eggs are laid in the water, close parental care must be shown. Therefore, whatever the size of the coelacanth population, there may be considerable danger in random fishing efforts during the breeding period.

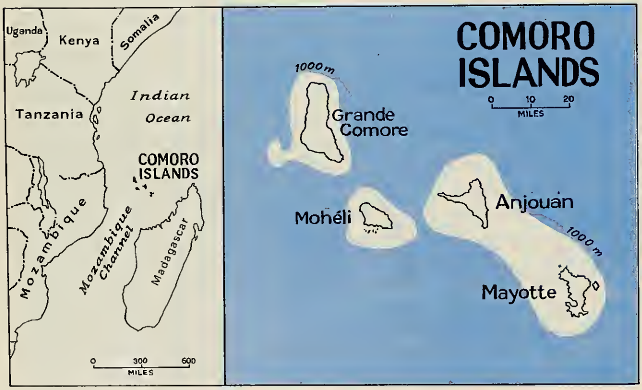
In 1966 I wrote, "Perhaps the next phase of study of the coelacanth should be conducted with the investigator holding a motion picture camera rather than a scalpel." I now consider this to be even more pertinent. When the results of laboratory studies now in progress are known, there will undontedly be a need for a second expedition to obtain a similar specimen.

But our need to know the ecology of the fish will not be met by this process. I am of the opinion that no random, or even systematic, fishing program will suffice. The present catch rate is too low, and even if one could devise a fishing technique that would allow a large catch to be made in a systematic survey of the area (which seems unlikely), the chances are too strong that the fish would be made extinct in the process. The only safe investigation of the general biology of this fish can come from direct observation. A systematic survey of the Comoroan deep slopes by means of photography, television, and observers in a submersible would, at the very least, tell us something about the physical and biological environment, even if no coelacanth were seen. A film record of a live coelacanth in its natural environment would be worth more than fifty specimens on laboratory tables, and I would certainly rather see the effort go in this direction.

There are, of course, also considerable legitimate pressures for the capture of a live specimen and its preservation in an aquarium. It would be a marvelous step for the science of biology, as well as for the public at large, if one could be put on general view. At the moment we do not know under what conditions the fish normally lives and can only guess at why it dies when brought to the surface, but the extreme stress of capture must be very important. I believe that the correct procedure would be to prepare a suitable tank, in which at least the



This large coelacanth was frozen shortly after it was caught.



parameters of pressure and temperature could be controlled, to install this tank on Grande Comore, and to instruct local officials in its operation.

In fact, such an operation could be set in progress without the enormous expense of a major scientific expedition. For example, mobilization of the local fishermen seems likely to produce one or two specimens per season, and better communication between the fisherman and the shore could improve the chances of a specimen being kept alive after capture. A fast launch summoned by radio could quickly bring the fish back confined in a simple tank of seawater. This would be much better than the present long paddle home with the fish towed behind, a hook through its head.

Study of the coelacanth has had a long and often frustrating history. Some 35 years after the discovery of the living *Latimeria chalumnae*, we are beginning to assemble a large set of data concerning the biology of this enigmatic fish. But a fundamental aspect of its biology—its ecology and general way of life—remains almost a complete mystery, enlightened only by inferences made from the specimens all caught at random by Comoroan fishermen. Such specimens have been studied with great success, but new methods, including the maintenance of specimens in aquariums and direct underwater observation of the fish and its habitat, will be needed before we can truly understand the biology of this curious relict of Paleozoic and Mesozoic times. ■

Unveiling the Black Widow

Venomous spiders have always incurred the wrath of man, but their poisons were never intended for such luckless victims

by John A. L. Cooke

"When Alexander reigned, it is reported that there was a very beautiful strumpet in Alexandria that fed always from her childhood on spiders, and for that reason the King was admonished that he should be careful not to embrace her lest he should be poisoned by venom that might evaporate from her sweat. . . ."

E. Topsell
The History of Four-Footed Beasts and Serpents
London, 1607

Deeply rooted in the mythology of many cultures, spiders are both feared and venerated. Superstition and popular imagination have endowed these diminutive creatures with enormous powers, including prognostication of forthcoming events and the cure of many diseases. Such beliefs are not confined to primitive peoples; even sophisticated New England yachtsmen still believe a southwesterly gale is imminent if spider silk is found streaming from the rigging of their boats.

It is, however, the widespread and unshakeable conviction that most spiders are poisonous that has given these fascinating animals their undeservedly evil reputation. While it is true that over 99 percent of the more than 20,000 known spider species possess so-called poison glands, which discharge through the tips of their fangs, this conjures up a wholly misleading impression. The very words *poison* and *venom* are highly evocative, and one instinctively relates them to man. Clearly, for a proper understanding, we must consider the role of the poison glands in relation to the normal prey and predators of the spider. It is unfortunate that most research on spider venom has concentrated on the very few species that can affect man, leaving virtually untouched the study of the spiders' secretions in nature.

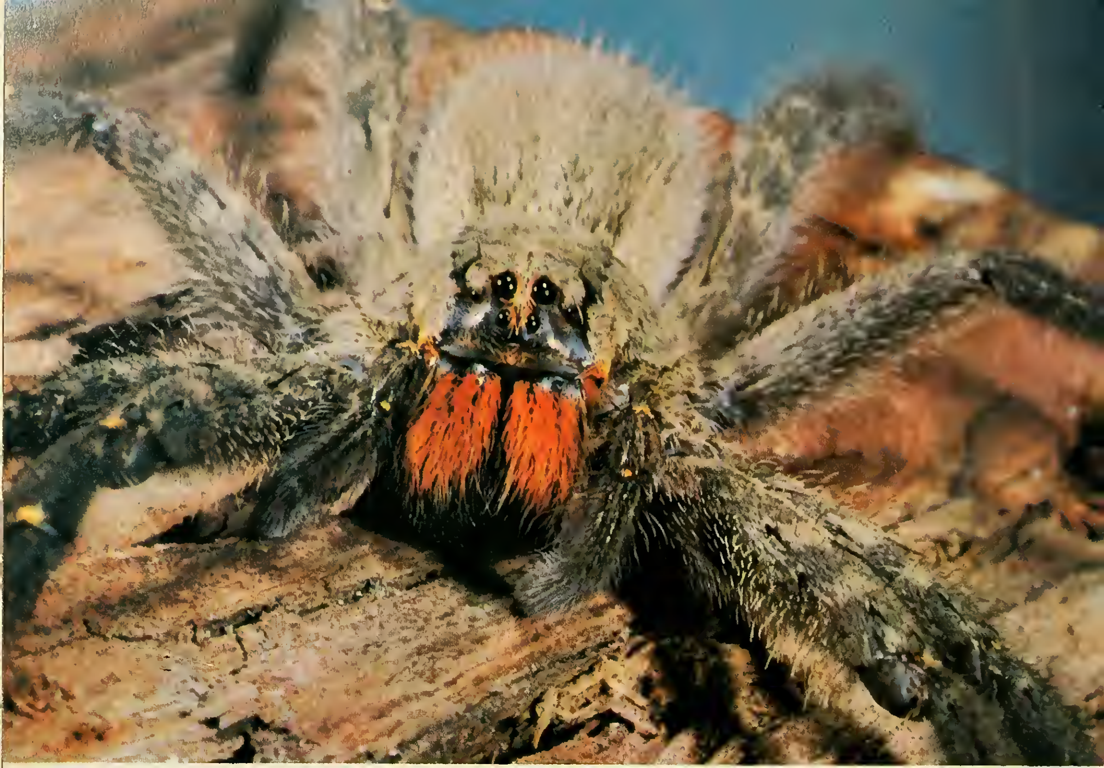
The original function of the glands was probably to produce digestive juices, for a spider must predigest its prey to a souplike consistency before consuming it. From this stage the evolution of components that might paralyze the victim and make its capture quicker and easier is a logical step.

Most spiders have progressed no further than this stage, but a few have gone on to evolve a violent-pain-producing component that will teach intending predators to keep clear. To be most effective, this capacity should be accompanied by the development of some form of distinctive warning coloration. This does occur in several species. In the large African theraphosids, for example, the fangs are surrounded by crimson hairs that are vividly displayed when the spider raises its body to the almost vertical threat posture. It is possible that the crimson marking on the abdomen of the black widow serves a similar warning function, a supposition supported by the existence of black widow mimics. In the genus *Scytodes* the venom glands have evolved a further function. They secrete a sticky, toxic gum, which the spider squirts out over the prey from some distance away.

Although many spiders are able to subdue their victims rapidly, others begin feeding while the prey is still struggling; thus, it would seem that in many cases the poison glands have been misnamed. In various parts of the world, however, there are at least a dozen kinds of spider whose bite seriously affects man or his domestic animals. Historically, the most feared spider was

Drawing silk from spinnerets, a female black widow fashions her trap for prey. Her venom has caused most spider-related deaths in North America.

Despite their formidable appearance,
North American tarantulas are
a serious threat only to their prey—
beetles and grasshoppers.



The crimson hairs on the mouthparts of this South American wandering spider warn potential predators that its bite is painful.

the tarantula, *Lycosa tarentula*. This large wolf spider abounds in southern and eastern Europe, particularly southern Italy. It is quite distinct from the large, hairy desert spiders commonly called tarantulas in the United States, which have a totally undeserved reputation as dangerous animals, but which are, in fact, harmless to man.

Interestingly, it has recently been shown that even the European tarantula has been wrongly accused, that it does not inflict the dreaded bite attributed to it but is quite harmless. The real culprit in tarantism is none other than the famous black widow spider. The black widow, *Latrodectus mactans*, is a comparatively small, inconspicuous, and secretive member of the family Theridiidae, the comb-footed spiders. These include several common cobweb-spinning spiders found in buildings. *Latrodectus*, whose name comes from the Greek and means "secret biter," is a genus of worldwide distribution containing several species. Although all are highly venomous, only *L. mactans* is synanthropic, posing a serious threat to people.

Known by a wide variety of local names in different countries, the spider's American name, black widow, presumably refers to the popular belief that the female always consumes her spouse after mating. While this does occur, particularly if the female is not well fed, it is by no means inevitable. The male is much smaller than the female, weighing one-tenth to one-fiftieth, and sometimes less than one-hundredth, as much. As he touches her web, he begins to pluck at the threads and vibrate his body, slowly advancing with an irregular gait. After some minutes he begins to destroy parts of the web, eventually isolating the female on a narrow swath of silk. If the female is receptive and does not chase him off, the male advances until he can touch the object of his attention. Tapping and stroking her, the male rapidly begins to move around her, spinning a fine film of silk that has been called a bridal veil.

After he has been in the web for nearly two hours, he mates by inserting the tip of his specially modified pedipalps—short leglike feelers situated on either side of the mouth—into the genital opening on the undersurface of her abdomen. Immediately after copulation, which lasts about five minutes, the male is exposed to his greatest risk, for the female can easily seize him with her fangs at the moment of disengagement. If the female is placid, however, he should survive, and he may even continue to live in the female's web until old age supervenes a few days later.

The bite of the black widow

shows considerable diversity in its effect upon humans. This undoubtedly reflects differences in the dosages received, the physical condition of the victim, and probably very significant, differences in the potency of the spider venom in different parts of the world. There is little information available on comparative lethality of black widow venom, but it appears that North American populations are more potent than others.

The bite is not painful and may often pass unnoticed. Local effects are limited to minute puncture marks and a slight reddening and swelling, but within a few minutes an intense pain begins to develop. Starting in the lymph nodes of the armpits and groin, it rapidly spreads until within about an hour the lumbar and abdominal regions, as well as the thighs, are affected. The pain is incessant, acutely agonizing, and sometimes paroxysmal. The victim continues to deteriorate, exhibiting general symptoms of shock and nausea accompanied by cramps, sweating, facial spasms, priapism, breathing difficulties, hypertension, and changes in heartbeat. In time, these symptoms may also be accompanied by mental disturbance and ulceration of the digestive tract. In most cases the symptoms subside within three or four days, leaving a feeling of general malaise and local hypersensitivity, but it is not uncommon for some patients to remain hospitalized for one or two weeks.

Although the bite of the black widow is traumatic, in most cases the prognosis is favorable. Between 1726 and 1943 there were 1,300 reported bites from all 48 states, with 55 fatalities—a mortality rate of 4 percent. It should be remembered, however, that only a small proportion of the total number of bites are recorded in official statistics and that the actual number of cases is probably much higher. With the introduction and general availability of an effective antivenin, the mortality rate has been reduced by about 90 percent.

A curious feature of black widow bites is that they tend to occur in epidemics, clearly reflecting the natural fluctuations of the spider populations. Such epidemics have occurred in Spain (1830), eastern Russia (1838–39), France (1878–79), Uruguay (1910), and Yugoslavia (1926–27). A severe outbreak of 946 cases in Italy between 1946 and 1951 surprisingly resulted in only two fatalities (0.2 percent), suggesting that the venom of the Italian population is less potent than elsewhere. The majority of those bitten are agricultural workers, particularly in regions where harvesting is still carried out by hand.

The black widow typically feeds on a variety of small insect prey, capturing it in a durable web that is usually spun in a wide range of dry, shaded sites near the ground. Webs may be found in rockpiles, culverts, and in small mammal burrows, as

While tarantula fangs can easily pierce human flesh, the bite rarely causes more than momentary, localized pain.

Jumping spiders have well-developed eyes and hunt by sight. They occasionally bite people, but the effects of their venom are not serious.

well as in grain crops. The spider also shows a predilection for old buildings, where it may occasionally hide in clothing.

The black widow is not an aggressive spider, biting only in self-defense when trapped and pressed against the body, but this is a rare occurrence. It is in the old-fashioned outdoor privy that the black widow presents the greatest hazard. Beneath the seat the spiders flourish, spinning extensive webs to catch the innumerable flies. Anything brushing against the web will attract the spider's attention and be attacked as prey.

Despite the potency of its chemical armory, the black widow is not without enemies. The eggs are attacked by parasitic flies and wasps, and the spiders themselves are the prey of alligator lizards, mud dauber wasps, and the exclusively spider-eating spiders of the genus *Mimetus*.

The toxic effects of black widow venom have been traced to four protein fractions within the secretion of the poison gland. Three of these fractions are effective against insects and presumably represent an ancestral type of venom that might be expected to turn up in a variety of other spider species when they are examined. One fraction acts as a rapid knockdown poison, while the other two function as slower acting poisons that cause irreversible damage to the nervous system. Thus, a captured insect is immediately paralyzed and stops struggling to escape, although it is not killed until some time later. This principle, which is also found in pyrethrum-DDT insecticide aerosols, gives greater flexibility in prey capture and allows the spider to feed on a broad spectrum of insects.

Only the fourth fraction, which acts by interfering with the transmission of nerve impulses, particularly to muscles, is active against warm-blooded animals. The nerve cell is separated from its muscle fiber by a narrow synaptic space, and electrical impulses are transmitted across this gap by a chemical messenger, acetylcholine. Black widow venom selectively poisons the motor nerve endings by inducing the secretion of acetylcholine until the supply is exhausted. Recent electron microscopy studies reveal that this stage is followed by extensive physical damage to the nerve ending. Treatment with *Latrodectus* antivenin will rapidly restore the nerve ending to its normal working condition.

Comparative studies on the venoms of European and American populations of black widows and other species of the genus show that, although there are minor differences in chemical composition, the venoms are all very similar and extremely potent. Surprisingly, it was found that the brown widow, *Latrodectus geometricus*, which has never been regarded as dangerous, has the most lethal venom. The explanation lies in the fact that the species produces very little venom and is less aggressive and irritable than other members of the genus.

The diminutive males and immatures of the genus *Latrodectus* also have so little venom that, coupled with their inability to penetrate human skin with their tiny fangs, they do not constitute any danger to man.

In the United States only one other group of spiders, those in the genus *Loxosceles*, warrants consideration as a potential danger to man. Often called brown spiders, the best-known species, the brown recluse, or fiddle-back spider (*L. reclusa*), is found in many of the warmer areas of the country.

Several closely related species occur in the United States, extending from California through the Southwest and into the southern central states. Because they often hide in old crates and boxes, which may be transported to centrally heated buildings in cooler parts of the country, their range is slowly spreading under man's influence. Thus, colonies of the brown recluse,

The venom of the brown recluse can be harmful to man. This spider has been extending its range in the United States.

Loxosceles reclusa: a Chilean species, *L. laeta*: and the originally Mediterranean species *L. rufescens* have become established in scattered locations on both the east and west coasts of North America.

The most striking diagnostic feature of the brown spiders is the arrangement of their six eyes into three well-separated groups of two. This is in contrast to the eight eyes present in most other spiders. They are active spiders that construct tangled webs of flocculent, bluish silk, but because they are nocturnal and inhabit secluded niches beneath stones or logs or within cracks and crevices in rocks and caves, they are seldom seen.

In 1934 convincing evidence was assembled to show that the bite of *Loxosceles laeta* in Chile was responsible for a very common and extremely unpleasant form of skin tissue destruction in humans. It was not until 1957, however, that *L. reclusa* in North America was shown to produce similar effects in laboratory animals and the potential hazard of bites from these spiders was verified. Since the resulting condition, known as necrotic arachnoidism, had been reported in the medical literature since 1872, it is curious that the prime causative agent escaped detection for so long.

Unlike the bite of the black widow, which produces a systemic effect, crippling the whole body, the bite of the brown recluse is generally localized in its impact. Some discomfort may be experienced at the time of the bite, but usually several hours pass before the victim is aware that anything is amiss. First a blister, often accompanied by a certain amount of pain, develops at the site of the bite. Then, as surrounding cells are killed off by the venom, the victim's skin turns purple and eventually black. The resulting gangrenous lesion may be an inch or two in diameter, and after the necrotic core falls away, the patient is left with a deep pit that heals only gradually, as scar tissue slowly accumulates over several months.

Cases have been reported in which hypersensitive individuals develop severe systemic symptoms, which can persist for up to a week, and in very rare instances the bite has proved fatal. During a recent five-year period in Texas, sixty cases of brown recluse poisoning were reported, and four were fatal—a mortality rate equivalent to that of the black widow prior to the widespread availability of antivenin. Although an effective antivenin against *Loxosceles laeta* bites has been developed in South America, it is not yet available in the United States.

The chemistry of *Loxosceles* venom is not understood, nor is its precise mode of action. One problem in attempting to discover the way in which this venom works is that different experimental animals respond differently. When the venom is injected into rabbits, for example, only minimal systemic effects are observed, but extensive necrosis of the walls of blood vessels occurs in the area of the injection. This reaction is accompanied by local thrombosis and hemorrhage, followed by the formation of an abscess. Ultimately, as in man, an ulcer covered by a blackened scab forms, which is eventually sloughed off.

In contrast, mice similarly treated usually die from systemic effects within 24 hours, with no trace of necrotic lesions being formed. It is possible that this difference in response is due simply to the size of the subjects, and hence the proportionate dosage received, but it could also reflect the fact that these spiders, more likely to be attacked by small predators, have evolved a specific antirodent component in their venom.

Thus, the black widow and the brown recluse are characterized by two very different types of venom, the neurotoxic, with its widespread systemic effect, and the hemolytic, with its predominantly local tissue destruction. The venoms of these two spiders are, by far, the most intensely studied for the simple reason that they are the ones that have had the greatest impact on our lives. What little we know of the venoms of other truly poisonous spiders suggests that they, too, belong to one or the other category, or occasionally to both. The imposing South American wolf spider *Lycosa raptoria*, for example, has a painful bite that causes extensive necrosis and presumably contains both types of venom.

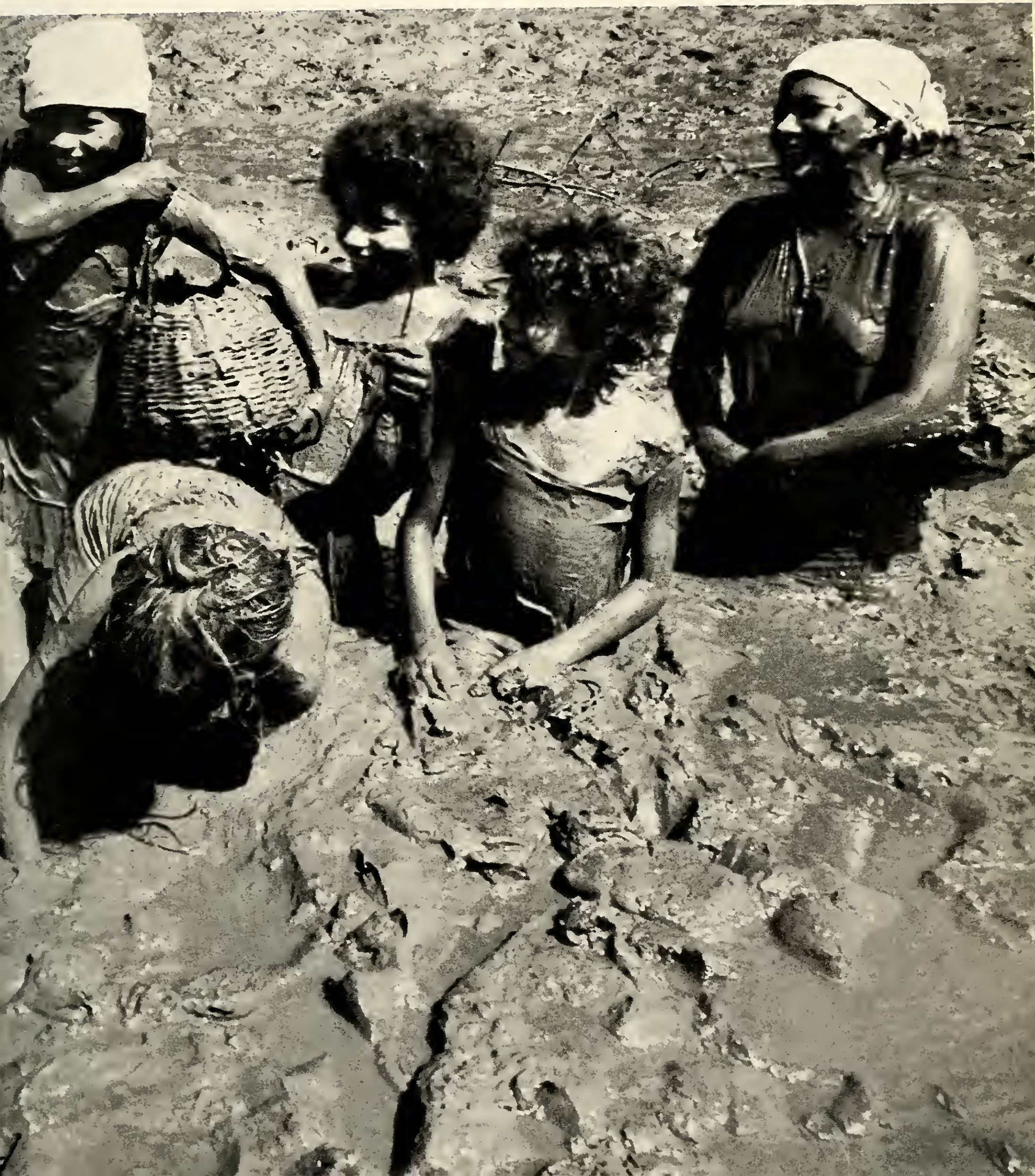
In his arrogance man considers all venoms in relation to himself and rates them effectual or ineffectual accordingly. Obviously though, spider venoms evolved independently of man and probably long before he ever appeared on earth. The small number of geographically separated and largely unrelated spider species with venoms toxic to man acquired this potency fortuitously. Vertebrates of any kind play a small role in spider nutrition, and it is improbable that the poison gland secretions evolved to pacify such prey. Spiders, however, are attacked by a variety of lizards, birds, and small mammals, such as roadrunners, grasshopper mice, and shrews. The appearance in the venom of a factor causing immediate and excruciating pain to these predators would clearly confer a significant selective advantage. This would be much greater than the advantage to be gained by mere distastefulness: the spider would not have to be eaten for the predator to discover its mistake. It is not surprising that such a venom, designed to debilitate a small rodent by disrupting the delicate chemistry of its nervous system, should also have an effect upon larger animals, for the use of acetylcholine in synaptic transmission occurs throughout the animal kingdom.

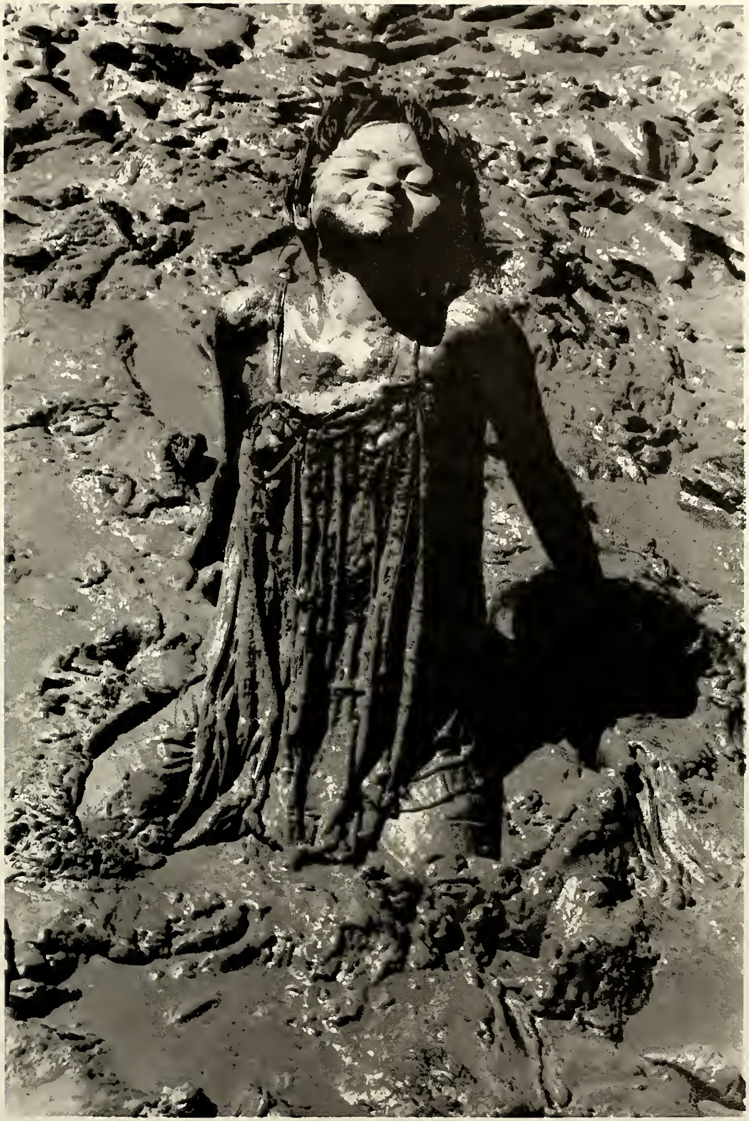
Our knowledge of spider venoms has increased substantially since Alexander was unnecessarily deprived of his pleasure. But much more remains to be learned about the secretions of the many spiders that rarely come into contact with man before we can more fully appreciate the evolutionary subtleties of venom, instead of merely deploring our sensitivity to it. ■

Moments in the Mud

Why are these young ladies doing something that all children—and many adults—dream of?

photographs by Maureen Bisilliat





At first sight, the women and girls of the village of Livramento in northeastern Brazil seem only to be enjoying a fantastic frolic in the mud flats of the Paraiba River near the Atlantic Ocean.
Yet a closer look, next page, reveals that more than play is involved.

Pipe-smoking mothers also join in the muddy affair. For the whole party, the layer of slime provides protection from the tropical sun and the swarms of malarial mosquitos. But the main purpose of the escapade is to catch by hand the silvery fish that feed in the shallow ponds when the tide falls. The fish try to escape by swimming into the watery ooze. The pursuers, with laughter and abandon, slither after the fish, often catching them at arm's length down in the mud.

A New Age For Aging

Continued from page 18

semia, found in the Mediterranean region.) Itano proposed that the mutation responsible for this disease involved the substitution of a poorly translatable genetic code word for a readily translatable one in the defective gene. This idea was independently rediscovered by Gunther Stent, Bruce Ames, and the author, who applied it to aspects of development and aging.

The basic idea behind our thinking and experiments is that as cells mature they may shut off the ability to read, or decode, certain code words. The effect would be that all genetic messages written down in sequences that include nondecodable words could not be used to produce working parts of cells, including replacement parts.

If this idea were correct, one might expect different kinds of cells from the same individual to operate on different genetic languages. A genetic language is definable as a particular combination of code words that includes at least one word for each of the twenty amino acids. Because there are about sixty usable words in the genetic dictionary, it is obvious that a huge number of different kinds of languages are possible. In fact, because there are about three times as many code words as there are amino acids for them to specify, a sequence 100 amino acids in length (about average for a simple protein) can be written down in 3^{100} different ways within a given segment of DNA.

Even allowing for some inability to distinguish between certain words, it now appears that at least 10,000 different exclusive sets of code words could be used to specify 10,000 different kinds of cells. This is many times the number of different kinds of cells in the body.

One of the predictions implied in such a theory is that certain steps needed for the translation of a given word will be carried out by certain kinds of cells but not by others. There are now at least fifty studies on various animals and plants that show some deficiencies in the translation machinery from one cell type to another. (Some cancer cells, it now appears, may have reacquired lost translating ability, perhaps as a result of "cancer virus" infection.)

Two findings by Michael Bick and the author are extremely pertinent in this regard. The first was that extracts from old soybean cotyledon tissue are unable to fully carry out the step involved just prior to the decoding of genetic information. (This step is the attachment of the proper amino acid to the right decoder molecule.) Young tissues, however, were perfectly capable of doing this.

The second finding was that old tissues contain a substance that specifically seems to block this step. These findings imply that the tissue is programmed to manufacture a "self-poison" (possibly similar to the chalones) late in its lifetime, and that such a "poison" effectively blocks the production of materials needed for an indefinite existence. The lifetime of this very tissue can be extended manyfold by applying a specific plant hormone, kinetin, to the tissue before it ages.

Equally important is an unpublished finding by Gerald Hirsch. He found that cellular material present in extracts of liver cells was unable to produce free soluble proteins if it was given a message from another tissue. These experiments imply that different cells do have different languages.

Roger Johnson and the author have recently made another promising discovery that may be the needed principle that will tie together many of the seemingly different effects of the aging process. Working with dog tissues, we found that nondividing cells lose a particular kind of DNA. This DNA is involved in the manufacture of the machinery needed to produce any kind of protein, the working parts of all cells. This genetic material, known as rDNA, codes for the ribonucleic acid that is part of the ribosomes—the machines through which the genetic messages are threaded as they are translated into working proteins.

It may be highly significant that, in the studies completed so far, this loss of rDNA occurs only in nondividing cells—brain, heart, skeletal muscle. Liver and kidney cells, for example, do not show such losses. The net effect of the gradual loss of some of this genetic material would be to reduce the maximum rate at which protein could be synthesized under stress. Thus, such different afflictions of the elderly as heart failure (which requires the manufacture of heart muscle proteins if it is to be prevented), inability to detect and reject cancer cells (which requires the rapid manufacture of antibody-like substances to kill off the aberrant cells), and a decrease in the efficiency of the hormonal systems (such as occurs in adult-onset diabetes) may all be ascribable to this fundamental loss of rDNA in nondividing cells. Studies are now under way to test a few of these implications.

It would be too sanguine to state at this time that vital functions could be regenerated simply by reinstating lost abilities to decode one or a few code words. What is needed, of course, is research to find out whether this simple, though versatile, mechanism really dominates the control of development and aging.

Predicting what will happen in, say, the next ten years in the field of understanding and controlling the biological aging process is about like giving a 10-day weather forecast. We know enough about the present situation and the main trends in this area of science to make an educated guess as to what will happen. Barring unforeseen breakthroughs in other areas of biomedicine that might provide important insights into the aging process, the key, limiting factor is whether the needed specific effort will be supported by society. This is an unsettled question right now.

One reason that research on aging has not received the emphasis it deserves has to do with the aging of bureaucracies themselves. New bureaus and institutes are often vital organizations; as they grow older they are concerned more with maintaining the status quo than with imaginative progress.

Within the government (the logical source of funds for basic research), two agencies have a prime interest and obligation toward the health of the elderly: the National Institutes of Health and the Veterans Administration. The National Institutes of Health has been charged with responsibility for support of research on medical problems; the Veterans Administration has responsibility for caring for the veterans of our wars. But both agencies are hampered by inadequate budgets.

Research on aging suffers from a particular disadvantage within the National Institutes of Health because of an absence of experts in decision making and advisory posts sufficiently aware of the details of the process. Instead research proposals are sent to groups of specialists in bacterial genetics, in epidemiology, cell biology, or general biochemistry. The members of each of these review panels or study sections are, almost without exception, leading members of the biomedical research community. But, if the review comments this author has seen are representative, they are quite underinformed about the status of aging research—a field that is alien to their natural interests and, in fact, competitive with the professional objectives (funding) of most panel members.

For a brief time, just before the last election, it looked as though the starvation period for research on aging was about to end, for Congress had passed (by almost unanimous votes in both houses) a bill that would have established a National Institute for Research on Aging. It was jointly sponsored by leading members of both parties and supported by all of the research and service organizations concerned with the needs of the elderly. This bill created the institute that was unanimously called for by the representatives to the 1971 White House Conference on Aging (Research and Demonstration Section), convened by the President in December, 1971.

The euphoria in the aging research community was short-lived, however, for the President killed the bill by pocket veto. The reasons given for the veto were: (1) it would cost $200,000,000 and (2) the work would duplicate work already being carried out within the government. Obviously, there has been some failure in communication, for it is hard to believe that a highly intelligent man would have made this decision if he had been apprised of all of the relevant facts. Perhaps the present governmental shake-up will open the lines of communication and give the President a more balanced view of the needs and opportunities in this field of research when the bill once again is passed and reaches his desk.

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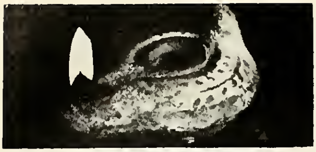

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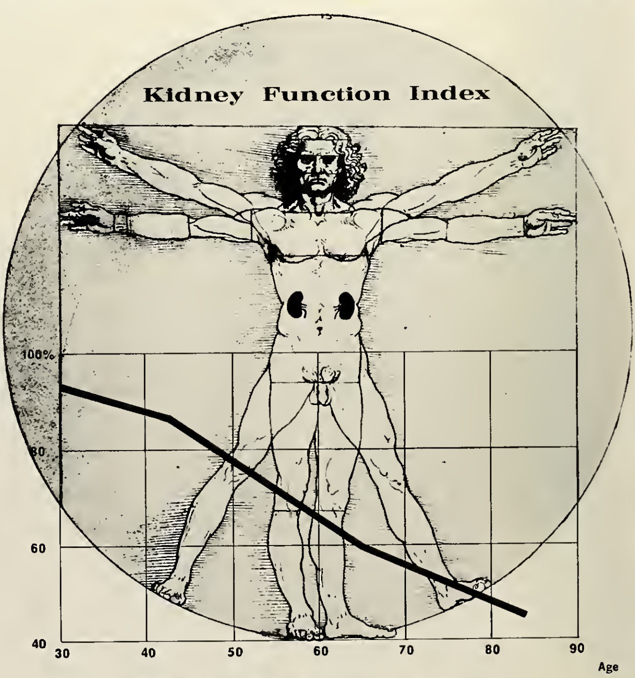
What happens in the next ten years thus depends directly on a total imponderable. If the institute is established and adequately and imaginatively funded and administered, it seems likely that by the year 1983 we will understand, in depth, the details of cellular and bodily aging. If no special effort is made to understand this most universal of all human afflictions, the date of understanding and possible control will be pushed back to the beginning of the twenty-first century, a date too late to benefit most of us alive today.

The eventual understanding and control of the aging process will cause a revolution in human affairs. Already a few studies are under way on the social consequences of greatly retarding or abolishing aging and death. A few misconceptions should, however, first be laid to rest. Some of the evidently misinformed opponents of greater, healthy life-spans seem to believe that the world would become populated with decrepit, patched-up, wizened, senile people, perhaps fed through tubes and moving with the aid of electronic prostheses. This ugly picture is totally false, for there is no way to appreciably increase life-span except by improving the body's physical state. Instead, humans that live for 150 years or more will be healthy for a much greater percentage of their total life-span. Men and women of highly advanced age will possess bodies like those of much younger people. In fact, their minds will be even more improved, for the greater years of optimum health will provide more opportunity to assimilate the world's wonders and lead to a greater measure of wisdom—the only intellectual commodity that often improves with age.

Because the healthy middle years of life will be doubled from the present 30 or 40 years, each individual will spend more time as a contributor to society. The average professional of today requires 25 to 30 years to acquire his training—mostly at the expense of the producing members of society. If the post-training years were doubled, every person could give much more back to the pool of resources from which he derived his start.

As the societies of the world evolve, there will be many changes in the kinds of creative activities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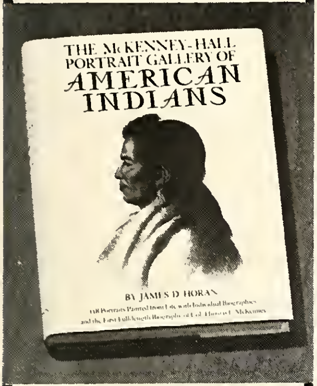

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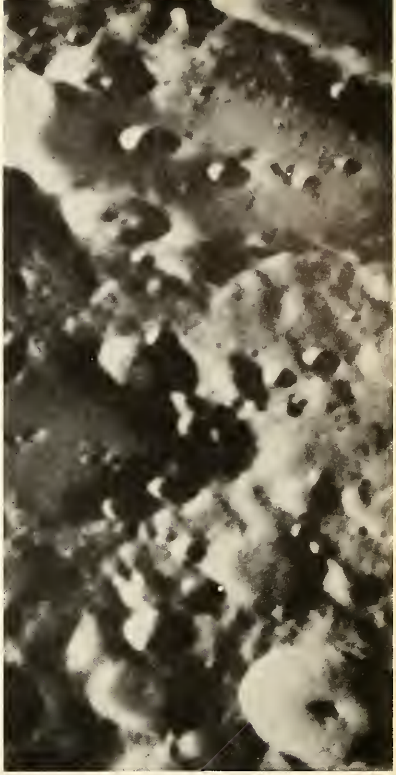
open to men and women. People with many decades of optimum health will find it desirable, if not necessary, to move from one kind of occupation to another. One way in which continual retraining in new skills and professions could well take place would be through a regular system of educational leaves-with-pay, much like the sabbatical system that now operates in universities. Every five or seven years, a person could take a year or so to acquire new skills and to refurbish old ones. Plans should be made now for the restructuring of educational institutions so that a continuing re-education will become the rule rather than the exception.

As machines take over the more onerous and repetitive tasks men have performed, opportunities for new careers in the so-called service area will evolve. It is unfortunate that there is not a better word than *service* (from the same root as the word *servant*) to describe the kinds of creative things people can do to make each other's lives enjoyable. Such efforts range from art, music, poetry, and beautiful gardens, to the care of children, entertainment, and creative conversation. As men escape from a subsistence society, in which work must be done to provide for life's necessities, a much more fulfilling kind of work, one directed toward the improved enjoyment of life, will come to dominate.

In time, all of these joyous prophecies will probably come about anyway, provided we have wisdom, foresight, and a little luck. But they will be available to those who read these pages only if the minuscule investment needed to understand and perhaps control human aging is made in this coming decade. What is commonly termed the Protestant ethic encourages some sacrifice now (work, saving, investment, education, research) in order to derive greater benefits in the future. After nearly a decade of disparagement and eclipse, it seems once again to be revealing its wisdom. One can only hope that this resurgence in the appreciation of investment will extend to what is needed to assure a healthier, longer life for all—basic research on the most universal human affliction, aging itself. ■



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Social Systems, Sex,

Amazonian Cosmos, by Gerardo Reichel-Dolmatoff. *The University of Chicago Press, $12.50; 290 pp., illus.*

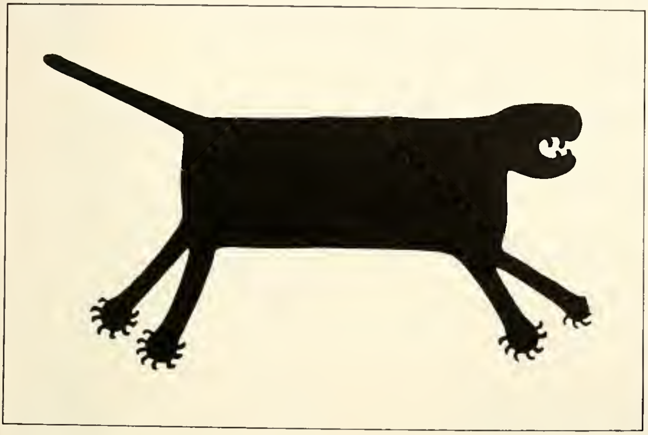
Cultural anthropologists are finally coming around to confirming what ecologists have long felt must be true but have not had the data to demonstrate: that where man lives dependent only on the resources within his tribe's home range, his destiny is set by the carrying capacity of that home range, just as it is for other animals. Most recent cultural anthropology either brings its descriptive guns to bear on the way the tribe harvests its resources or describes the social glue that holds that resource-harvest machine together. Few studies deal with the coevolution of the tribe's social institutions and the properties of the resources in the home range.

Reichel-Dolmatoff has taken on this difficult task in *Amazonian Cosmos,* and has done a masterful job of showing us how the sexual sociology and psychology of the Desana Indians of the Northwest Amazon is highly adaptive in the context of maintaining a stable tribal density in a rain forest with a river running through it.

Before digging deeper, I would like to comment on an aspect of resource harvest philosophy that underlies his analysis. Anthropologists often take the low density of primitive human populations as an indication that they are not at their terrain's carrying capacity, and assume therefore that their behavior need not be seen as having coevolved with that carrying capacity. From an ecologist's viewpoint, this would be like failing to recognize that two species of birds could have different carrying capacities on the same acre of forest, depending on the way each catches insects and depending on what size insects they each need. In this situation, the bird has done most of the evolving and the habitat little.

by Daniel H. Janzen

nd Survival



All the evidence indicates that this is also true of most primitive men. Modern man, however, is very close to the other end of the spectrum. He changes (evolves) his environment to meet his needs and fancies, and himself changes little. However, it is clear that the basic cultural information that he uses to guide his current activities has strong roots in those days when he was intermediate—an organism strongly coevolving with his environment. In *Amazonian Cosmos,* the analytical description of the Desana gets us to the very heart of this coevolution.

As Reichel-Dolmatoff says, he was most fortunate in finding a native informant who had been reared in the tribe under rules unperturbed by the introjection of foreign technologies and social goals. Yet the informant, Antonio Guzmán, had later made the adjustment to Columbian Spanish culture, which is no mean feat as any participant in a cross-cultural marriage can testify. If it is to be done well, such an adjustment requires extraordinary introspective ability and psychological awareness, as well as a good deal of practice. Both the ability and the practice contributed greatly to Reichel-Dolmatoff's success in extracting from Guzmán far more than a mere description of the way the Desana run their lives. And it is comforting to note in postscript that Reichel-Dolmatoff was eventually able to visit the Desana and corroborate Guzmán's interpretations of his childhood milieu.

The basic problem faced by the Desana is that of any territorial animal. How do you adjust harvest rates so that only the natural interest is removed? In short, how do you keep from hunting too much? Second, how do you adjust birthrates so that nobody starves? I may add a reminder here—death by starvation of a preproductive human means not only the loss of an individual from the tribe and a waste of the parents' physical reserves, it

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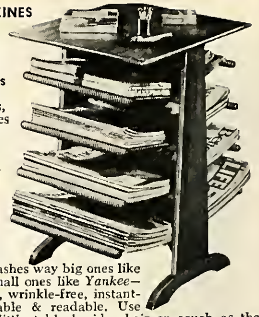
also means the loss of all the material that was used to support the child until its death.

The Desana, like most other tribes with a Stone Age technology and in tune with their environment's carrying capacities, maintain a balance through a complex interplay of sexuality and resource harvest, which is for the most part hunting in the Amazonian rain forest. Perhaps the most telling sentences in the entire book are to be found where Reichel-Dolmatoff summarizes Guzmán's description and analysis of Desana creation mythology: "Spiritually and psychologically, the Desana is not an individual we would call contented, balanced, and adjusted. His sense of being a man is dominated by the constant conflict between his attempts to balance the normal gratification of his sexual impulses and the prohibitions that his culture imposes on him."

So what's new about this? All we have to do is look next door to make the same statement in a modern society. In the other direction, if a male baboon could speak, his analysis would sound about the same. It makes us painfully aware that our incredible advances in resource gathering have not been accompanied by an equally advanced coevolution of psychological awareness with the ability to generate realistic sets of aspirations. Reading about the Desana Indians, and comparing what you see in modern culture, can be a most educational experience.

Guzmán, Reichel-Dolmatoff, and most of modern society seem to have missed the realization that the conflict between a person's desires and his resources is the inevitable result of a social system that allows the depletion of its resources to tell it when to stop—rather than arbitrarily setting the number of people substantially below possible carrying capacity. Only with the human density held significantly below the carrying capacity can we have a system where individuals are allowed to pursue their own whims without constantly coming up against natural controls that say "thou shalt not. . . ."

Reichel-Dolmatoff and Guzmán have done us a great service by documenting a large number of these social and natural controls in



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Desana culture. Some are obvious in their adaptive significance, but many are obscure and may be destined to remain so. Their obscurity often lies in our inability to see the total set of forces operating to keep a Desana tribe at a given consumer level. We cannot see how much resource is really there (even the Desana have difficulty determining this). We will often miss the adaptive meaning of rules that had their origin in dealing with the unpredictable nature of resource fluctuation. We cannot know to what degree social behavior is set by the tools at hand and to what degree the tools at hand are set by social behavior.

We may even be dealing with some traits that were of direct adaptive significance historically, but are now of indirect adaptive significance as convenient symbols. That is, it would cost more socially to remove them than to leave them imbedded in a currently socially adaptive pattern. There are modern analogies galore; Detroit can make a burglarproof car, but the cost is so high that it is cheaper to have a certain number of cars stolen each year.

Some of the social controls in Desana culture are worth emphasizing. Bear in mind that we are looking at hardly more than a Stone Age culture, but nevertheless a culture that has to live off only the natural interest of its home range, leaving the natural capital untouched. "A man who sires more than two or three children will be considered socially irresponsible and contemptible," and "is accused of being a bad husband and of causing too much work for his wife." Birth control is achieved through abstinence and contraception: "The women simply use mixtures of certain herbs that seem to have a very strong contraceptive action."

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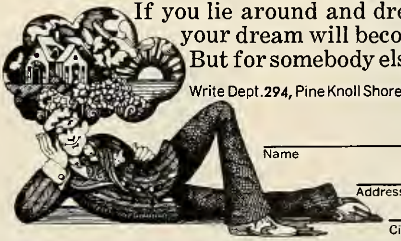

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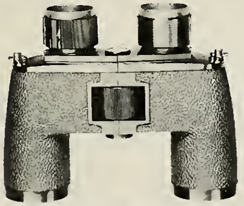

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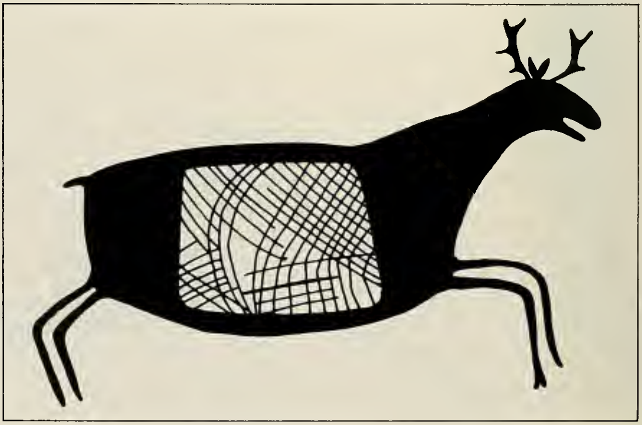
norms. The verb to hunt is . . . translated as 'to make love to the animals.' " I might add here that we have a not-so-primitive parallel in the Spanish language—*cazar* meaning to hunt and *casar* meaning to marry.

The amount of game taken has another major control system: the belief that each large game animal represents the soul of a dead person. If there is a shortage of large game, it is up to the shaman (payé), through negotiations with higher-order spirits, to determine if more souls (animals) can be released to be taken as game. Since souls are a rather ill-defined unit of barter and can come from deaths in other tribes, the shaman becomes a major evaluator of how much hunting is to be allowed, and has the means at his disposal to control it. It is of interest that all such systems deflect responsibility away from the person who must make the decision to take an action, such as hunting.

As alluded to earlier, much of the tribal social structure generates psychological anxiety. "In various ritual activities man fertilizes nature, but at the price of a great sacrifice in the sphere of his own sexuality. The fundamental rule of the hunter is sexual abstinence, and this rule demands a level of repression that cannot but lead to a state of profound anxiety." After Reichel-Dolmatoff describes a long list of the illnesses that beset the Desana, it becomes clear that they have very few serious pathogens, but they do have "a wide category of psychosomatic diseases with hysterical overtones." The majority of the diverse cures involve "symbolic acts of coitus and rebirth" and "demonstrate a perspicacity and insight into the psychological mechanisms that undoubtedly are very efficient in achieving at least a temporary cure." Interestingly, such things as snakebite are treated without the intervention of the shaman.

Reichel-Dolmatoff was able to construct a detailed chart of the Desana's pattern of resource harvest through the year. While we do not know the total environment from which they draw their food and materials, we can say that the pattern is sufficiently complex that its proper execution requires careful adherence to rules by most of the people in the small tribe. Antonio Guzmán has given us the background for a strong inference that much of the control that the group exerts over the individual is mediated through his or her sexuality. May I finish by pointing out that it was in reading *Amazonian Cosmos* that the reasons for the social taboo against masturbation first became clear—and somewhat terrifying. It is clear that our culture is likewise held together in great part through programmed sexual repression and release; the individual who masturbates has discovered a private escape from this sexual repression and in many ways has the potential of being very disruptive to society.

Daniel H. Janzen is associate professor of zoology at the University of Michigan and has conducted ecological studies in Central America.



AFRICANITY: THE CULTURAL UNITY OF BLACK AFRICA, by Jacques Maquet. *Oxford University Press, $7.95; 188 pp., illus.*

Books on Africa are written today by almost any visitor to the continent who wants to be regarded as an "expert" on a part of the world that is politically important, smartly fashionable, and still little known except for its animals. Books on the people who live in Africa, by those who know what they are writing about, who have both an intensive and extensive personal knowledge and—even rarer—a historical and comparative understanding of the continent, are very unusual. No criticism in these terms can possibly be made of the author of this book. Jacques Maquet has a long and deep experience of Africa; he is also a distinguished anthropologist whose many and influential writings show him to have an empathy with, and a scholarly comprehension of, the peoples of Africa, their hopes and aspirations for their future, and their pride and nostalgia for their past.

Maquet begins with a discussion of what is meant by African culture: what does it mean to be an African? He points out that to be black is hardly enough, an unfashionable view but a true one. As he says, "The African child is born Black but becomes African" and reminds us that "Harlem . . . still is not Africa." To be African is a part of cultural tradition and behavior. "Life-styles and work-styles are the heart of the matter: human behavior and things made in a social group." This cultural view of the world Maquet calls Africanity, a somewhat cumbersome word in English, defined by him as "[the] unique cultural face that Africa presents to the world." It is of course all too easy to prefer to forget the difficult concept of culture and to call upon racial views alone, views that are in a sense beyond proof and need only faith to be accepted. But as the author writes, "Africans did not create Africanity because they are black" and "The cultural unity of Africa does not rest on a mysterious African soul, an ideal essence or a certain way of feeling, but on a

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material base: the similarity of acquisition and production and their low yield." He continues during the chapter on "The Sources of Africanity" to discuss the ecological, historical, and other factors that make for a sense of unity within Africa and yet permit the myriad variations of that common culture from one society to another. Maquet groups these many cultures into six major ways of life, or civilizations: that of the bow, that of the clearings, that of the granaries, that of the spear, that of the cities, and finally that of steel, or industry. Although I have reservations about the meaningfulness of this classification, this section is one of the best overviews I have read on the nature of African culture; although terse, it is neither facile nor sentimental.

The central chapter is on the contents of Africanity, and it is a sensible summing up of anthropological knowledge of African societies. It covers the usual topics: birth and socialization, kinship and family, religion and magic, initiation, marriage, jural and social rules, government, and art. The necessary compression of data has not led to any gross simplification: there is simplification indeed, but not at the expense of discussion of the basic cultural and social principles of African society. The section on art is as good as the author's well-deserved reputation in that field would have us expect. The only criticism of this chapter is in its lack of demographic and other background data: one does not want tables of figures, but some harder information than we are given would help us see the continent more clearly.

There follows a chapter on the future of Africanity. This is not as good as the preceding sections. Professor Maquet's forte is his understanding of the traditional in African culture, and he seems not so happy in the discussion of modern democracy, military rule, and the like. The same preference results in one drawback in his coverage of societies: his virtual exclusion from consideration of urban life and the increasing urbanization and social stratification of today, with the cruel problems of underemployment and urban and rural poverty.

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The book ends with thumbnail sketches of one hundred African societies. These are not very meaningful, and instead of being geographically dispersed and typical, far too great an emphasis is given to societies in the Congo region where Maquet has done most of his research. There is a useful reading list and the photographs are excellent.

This is a good book, and has been well translated by Joan Rayfield from the original French version published in 1967. It is an excellent effort to produce something that is very difficult: an introduction to a complex subject that does not fall into the easy paths of racism, condescension, or sentimentality.

John Middleton
University of London

A God Within, by René Dubos. *Charles Scribner's Sons, $8.95; 325 pp.*

I read this book with several purposes in mind: to obtain a better image of its author, a man I do not know but do greatly admire; to accumulate facts for my own purposes; and to determine point by point whether I would have proceeded and concluded as the author did.

I can very quickly say that reading *A God Within* was valuable to me; at least twenty-five items in the selected bibliography have been marked for future study. There is a wealth of material in this book. Dr. Dubos emerges from these pages, I might add, as a kind and thoughtful human being, a valuable citizen, a stimulating companion. My admiration for him continues.

Would I have written as he has in *A God Within*? Do I agree with the many threads of his main argument? Not entirely. It seems to me that he has said many of the "right" things, but has then diminished his own effectiveness by ambivalence, or worse.

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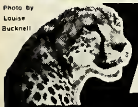
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environmental encounters are the same. Large groups of persons differ genetically from one another in systematic ways. Local geographies and local customs vary from one another. From this multitude of variations arise the individuals, diverse in heredity and experiences, who collectively constitute mankind.

A God Within has been written in praise of diversity. It has, however, also been written to identify the demon within. The demonic force in the modern world is identified by Dubos as the attitude that "we shall do certain things simply because we know how to do them." Dubos does not identify technology as the demon; rather, it is the attitude, the propensity to consider means as ends.

In his book Dubos has said the right things. Natural resources, for example, should not be squandered by a few generations of greedy men. If not corrected immediately, the disordered relationships between man and environment shall destroy the fitness of the planet for human life. Technology is acting, if not as man's master, at least as a molder of his destiny. The real prophets of doom are those optimists who see the future merely as more growth. The Faustian way of individual life is the way to racial death. The mythical need for more and more electric power is suicidal. The hope for the future lies, not in technological fixes (which Dubos despises), but in intelligent social design.

In making the above points, Dubos does not underestimate either the difficulty of changing individual attitudes or of untangling existing relationships. For instance, he mentions the complex interrelationships between working habits, automobile transportation, the packaging industry, and other aspects of life; these make it easier to merely manipulate details than to bring about significant changes. Addiction is an appropriate term for describing such relationships. In using the private automobile (rather than public transportation) and chemical insecticides (rather than biological control), man alters himself and his world so that his original choices are virtually irreversible. He becomes hooked.

In what ways does Dubos dissipate his effectiveness? First, he re-

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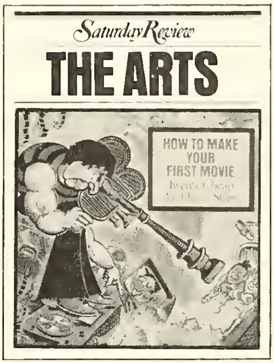

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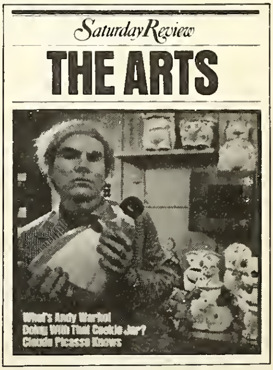

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fers in a pejorative manner to "prophets of doom." Who are they? In many eyes, Dubos, himself, is a prophet of doom; hence, by failing to identify his own targets, he only succeeds in making one of himself. Second, he denigrates professional ecologists. It is, at best, trivial to say that an environment judged to be fit only for rats and roaches is so judged through human eyes, not through those of rats or roaches. Third, I feel that he criticizes Jay W. Forrester in a way that creates an unnecessary gap between Dubos and the computer group at MIT. Computers are necessary for solving certain problems; this does not mean (as Dubos implies) that in using them we must deliver ourselves unto them.

Finally, Dubos makes what seem to be nonsensical statements harmful to his own case. I cannot agree, for example, that Stonehenge and other temples of the world have exacted as large a toll from nature as have modern industrial plants. Temples have neither exacted as much from, nor introduced as many poisonous wastes into, the environment. Nor can I admit that the bewitching charm of Paris or Rome has not been affected by the motor car.

More important, perhaps, than the dissipation of effectiveness described above is the choice of audience Dubos should have made to maximize his impact. *A God Within* represents a type of scholarly work—adequately documented, gentle in tone, and sufficiently profound—seemingly designed to evoke praise from one's peers. Praise does not effect change. In two decades or less Dubos and his peers will no longer be with us. If Dubos is serious about effecting lasting change in the world, in exorcising the demon within, he would be well advised to direct a simple, moving book to the high school and junior high school students of this country. I am sure that he could write such a book; otherwise I would not mention it. I am equally sure that it would eventually have a far greater impact on man's future than a shelf of such books as *A God Within.*

BRUCE WALLACE
Cornell University

POWER ALONG THE HUDSON, by Allan R. Talbot. *E. P. Dutton & Co., $7.95; 244 pp.*

America's new interest in the environment stems in part from a series of dramatic clashes between citizen environmental groups and the established power structure.

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One of the most significant of these clashes, the Storm King controversy, is the subject of *Power Along the Hudson*. In a confrontation of David and Goliath-like proportions, a small group of Hudson Valley residents, banded together as the Scenic Hudson Preservation Conference, has been battling both Consolidated Edison (the nation's largest private utility, which supplies metropolitan New York with gas and electricity) and the Federal Power Commission (the national agency that licenses hydropower plants).

The issue—whether Con Ed should be licensed to construct an ugly power plant on scenic Storm King Mountain, on the west bank of the Hudson River 40 miles north of New York City—is one from the standard environmental script. But in 1963, when the Storm King confrontation began, a citizen's right to challenge a governmental decision was unclear. During the course of the Storm King conflict, a federal circuit court ruled—for the first time—that a citizen organization could sue a governmental agency to protect the public interest in the environment (a ruling, by the way, that may be overturned or modified by the conservative Nixon Supreme Court). This unprecedented decision, and the new interest generated in the Hudson River (it was during this time that Bob Boyle, author and angler, revealed to the public that the Hudson was not all sewer, that it still contained real, live fish) made the Storm King controversy an environmental milestone.

Allan Talbot's treatment of the Storm King episode is thorough, readable, and dispassionate, qualities that immediately distinguish *Power Along the Hudson* from most environmental works. While the author's sentiments are clearly with the Scenic Hudsonites, his book is not a misanthropic diatribe on the plunders of modern-day robber barons, but a convincing, even compassionate, commentary on the narrow vision of bureaucrats whose professional specialization has impaired their capacity to sense the full impact of their decisions.

Motten L. Waring—engineer, former Con Ed president and vice-president, and the man who guided the utility's struggles against the Scenic Hudson group—did not intend to blight the scenery of Storm King Mountain or to damage aquatic life in the Hudson River. Yet, his engineer's training and the specialized assignment handed him by the company in 1960—to design a pumped storage power plant—prevented him from anticipating these possibilities before they were publicly thrust in his face by environmentalists. In 1967 Waring was dismissed from his position by the Con Ed trustees. Talbot notes that Waring "was made a villain and then a scapegoat for merely doing what was expected of him. . . ."

A decade after it was proposed, the Storm King project is still on paper. Its license has been approved by the Federal Power Commission, but the Scenic Hudson Preservation Conference continues to wage its battle in the courts.

Even if the plant is built, it will not solve the long-range problem of New York City's growing demand for electrical energy, but will only hold it at bay for a decade or so. This problem, the author notes, is almost unsolvable. To date, our society has made no attempt to enforce or even to suggest a quota for per capita consumption of electricity. Thus, the projected power demands of New York, and of our nation as a whole, can only be met at the expense of our natural surroundings. Americans demand a dependable supply of electric power. They also demand an environment that is scenic and healthful. As Talbot ably demonstrates, they cannot have both.

JACK HOPE

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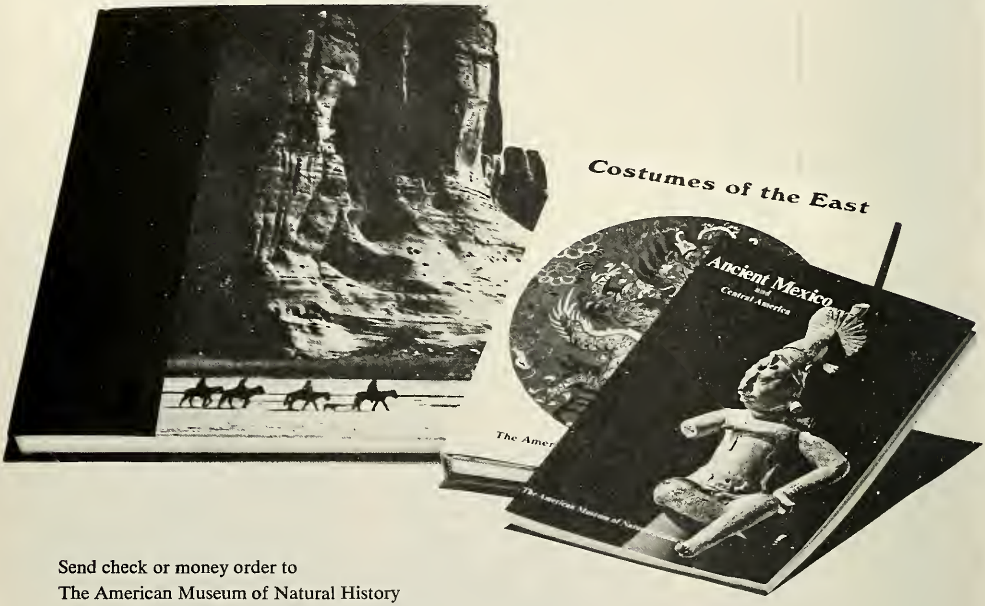
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Back to the Backyard

The last few years have been a bad time for us backyard astronomers. Our professional counterparts have been enjoying a golden age of discovery, replacing the speculation and romance of centuries with cold facts (they call it data) about our neighbors in the universe. When I first set up my telescope. I could use it to wander across the face of the moon. moving silently across its seas and over its mountain ranges. feeling I was alone on a new world. Now, even though I can't see it, I know the moon is a junkyard for space hardware, and footprints that will never be washed away mar the surface.

Blurry dark patches were all I could see on Mars, and even maps produced by professional Mars watchers at Pic du Midi in France and Fort Davis in Texas showed nothing but more elaborate blurs. It was still possible to dream that C. S. Lewis might have been right. and that bustling life did exist there along the bottoms of fissures deep enough to have retained air and water. Now a Mariner has sent back 5.000 closeup pictures. and Lewis's world has vanished.

Giving up the telescope for the armchair. squinting at journals instead of through an eyepiece. has been tremendously exciting. In the last decade we have not only gotten our first close looks at some of the planets and moons of the solar system, but we have also found exotic new kinds of objects in deep space. These findings are changing our view of the universe and promise to add whole new chapters to physics.

Within the span of a human lifetime. astronomy has gone through a revolution, an overturning of our established view of the universe. This period in astronomy can be compared to the impact the early years of this century had on physics, when the discovery of the atomic nucleus, relativity, and quantum mechanics enabled the human mind to account for the physical world to a degree that was undreamed of at the turn of the century.

The quasars. not much bigger than the solar system, turned out to be objects that shine with the energy of whole galaxies. The physics of 1973 just cannot deal with this concentrated energy production. The pulsars, which burst upon us just five years ago this month, turned out to be neutron stars, composed of collapsed matter the like of which can never be seen on earth. Now astronomers believe they have found black holes. stars that have collapsed in on themselves so far that they have disappeared from our universe. They search for these with the classic methods of positional astronomy—and with instruments designed to detect gravitational, rather than electromagnetic, waves.

Our skies today are crisscrossed with satellites carrying telescopes and a variety of little black boxes that see the stars only in ultraviolet, X-ray, or gamma-ray wavelengths. New. large telescopes in Chile and Australia are doing for the southern sky what the giant mirrors at Palomar and Lick did for the northern sky. Infrared telescopes are observing stars in the throes of birth, while radio telescopes are picking up the death throes of other stars.

The greatest discovery of all remains to be made, but more and more astronomers believe it is inevitable. Soviet radio telescopes are slowly surveying nearby stars for the signals that will unambiguously mean that intelligent life is thriving somewhere else in our universe. So many complex organic molecules have been found floating around in space that it is hard to believe that the precursors of life are not found on most or all planets.

While all this search and discovery is going on, backyard amateurs are quietly going about the business left for them: recording the brightening and dimming of a thousand variable stars, charting the trajectories of meteors through the atmosphere over their homes, sweeping the horizon for undiscovered comets. It is useful work; there just are not enough professional astronomers and observatories in the world to watch everything. There is no fame or fortune, although if you see a comet first it will be named for you. But if you're the sort, it can be fun.

So now I'm giving up my armchair for the telescope again. The journals will continue to pour out their data; I'll wait for the synthesizers to gather the facts and put them all together for me. I'll wait for the book to come out—or even the BBC movie. In the meantime, I'll be in the backyard.

Editor's note: John P. Wiley, Jr., who has written "Sky Reporter" for more than five years, does not intend to write any more columns for a while.

Celestial Events

by Thomas D. Nicholson

The Sun and Moon The sun, by mid-February, is almost two months past the winter solstice, and its motion toward the vernal equinox takes it northward toward the Equator at nearly its maximum rate. One result is a rapid change in the duration of daylight. Still shorter than night, the day is lengthening rapidly at this time of year, as sunrise occurs earlier and sunset later by a sum of three minutes per day. From mid-February until mid-March, therefore, the duration of daylight increases by an hour and a half.

Bright moonlight will fill the early evenings of mid-February, lasting all night on the 17th, when the moon becomes full. After the 17th, the moon rises later than sunset, until—with the last-quarter moon on the 24th—it rises about midnight. The waning crescent moon appears in the morning sky at the end of February and early March; becoming the new moon on March 4. From March 6 or 7 on, the moon will again be an evening object, growing from crescent to first-quarter (on March 11) and then waxing to its gibbous phase.

Stars and Planets In late February and early March, winter stars are prominent in the south just after sundown. At this time of year, it is easy to get to know Orion, with its seven bright stars, and also the bright stars of Canis Major, Gemini, Auriga, and Taurus, which are grouped around it. By dawn, the winter stars have all disappeared, but summer stars are then high and easy to find. The Summer Triangle, formed by bright Altair, Deneb, and Vega, is well up in the east, and Scorpius and Sagittarius are low in the south.

This year, February and March are rather poor months for planets. Except for Mercury, which will be in good position for about a week before and after February 25, Saturn is the only planet in the evening sky. It is in Taurus, to the left (east) of the bright star Aldebaran, visible in the south after sunset, setting about midnight. Although all the other planets are in the morning sky, only Mars will be seen easily, low in the southeast at dawn, among the stars of Sagittarius.

February 15: The moon has moved around its orbit to the point called apogee, where it is farthest from earth.

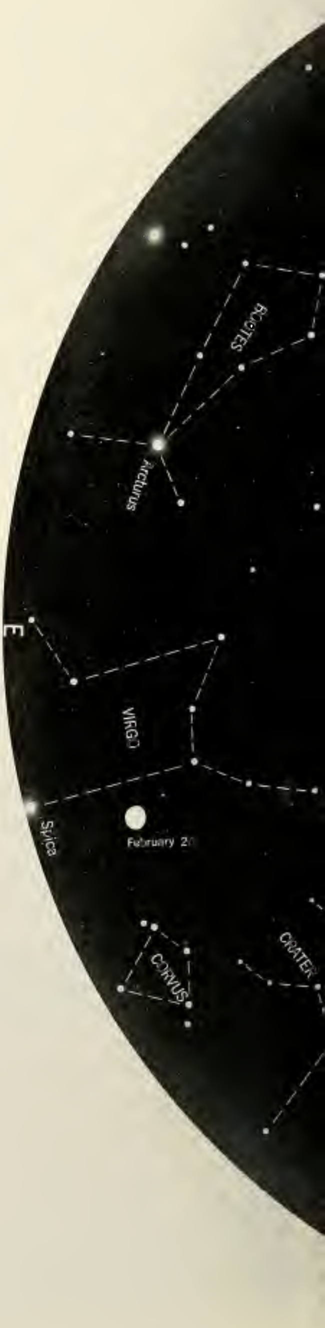
February 25: Mercury is at its greatest elongation (easterly) in the evening sky. This is a favorable elongation. The planet will remain above the western horizon until nearly the end of twilight. Observers with a clear western horizon may see it for about a week before and after this date.

February 27-28: The moon passes close enough to Mars this evening to occult the planet in skies over the Far East. Seen from the United States, they will be rising in the southeast quite near one another several hours past midnight.

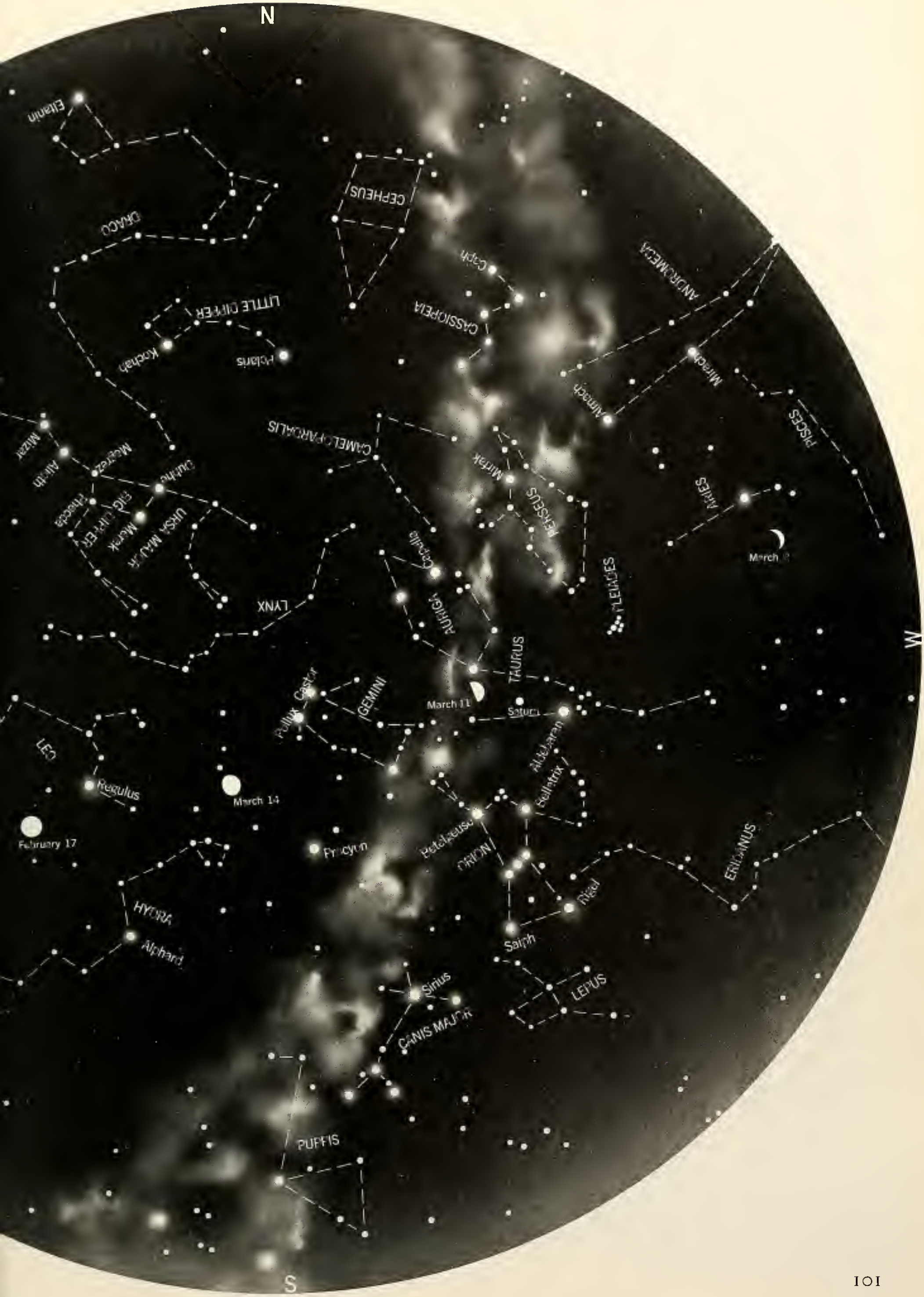
March 1-2: Jupiter is near the waning crescent moon, low in the southeast at dawn on both mornings. The moon moves from right to left above the planet from the morning of the 1st to the 2nd.

March 10: The moon is at perigee, nearest the earth. The waxing moon, just before it becomes first-quarter, catches up with Saturn tonight. The planet and the moon are both in Taurus, high in the south at dusk, setting about midnight. The moon is moving to the left (east) above Saturn during the night, passing closest to it about 5:00 A.M. on the morning of the 11th.

March 13: Mercury passes between earth and sun, at inferior conjunction, and enters the morning sky.



★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:15 P.M. on February 15; 9:25 P.M. on February 28; and 8:25 P.M. on March 15; but it can be used for about an hour before and after these times.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Biological Theories of Aging. A. Comfort. *Human Development*, Vol. 13, No. 2, 1970.

Advances in Gerontological Research, Vol. I to IV. B.L. Strehler, ed. Academic Press, Inc., New York, 1964–72.

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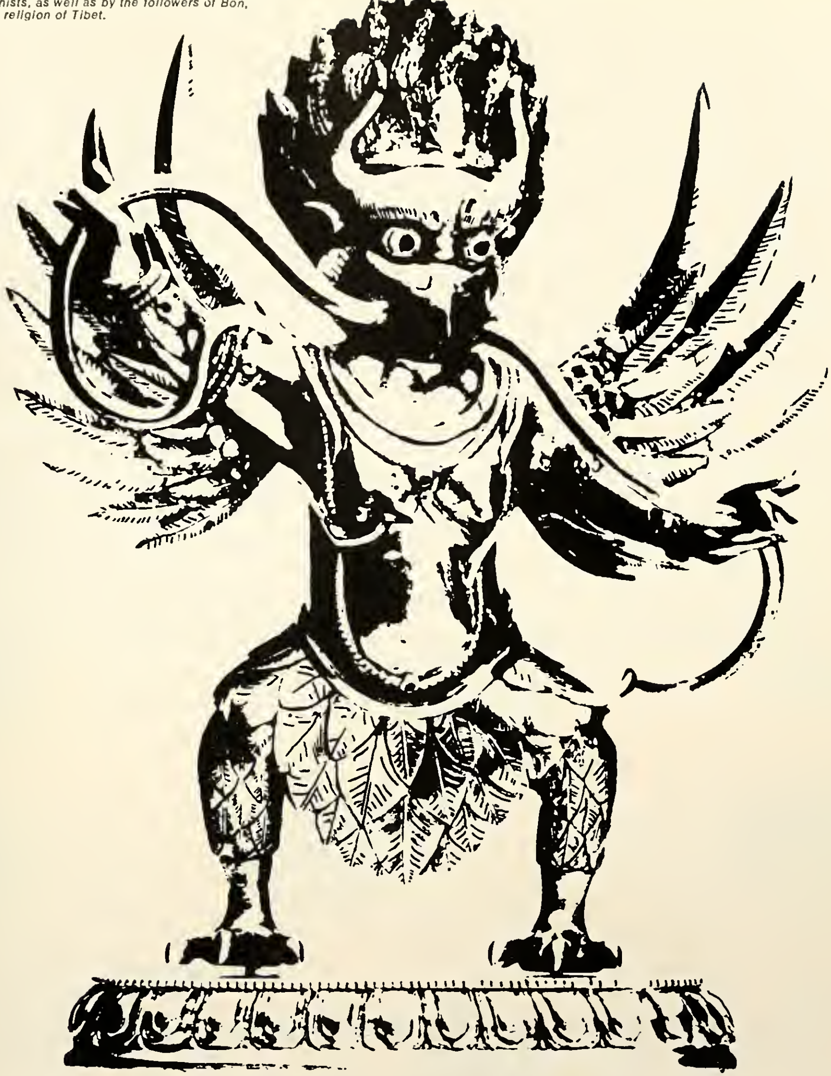

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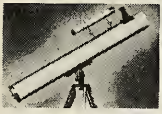

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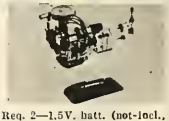

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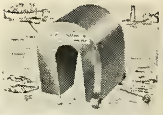

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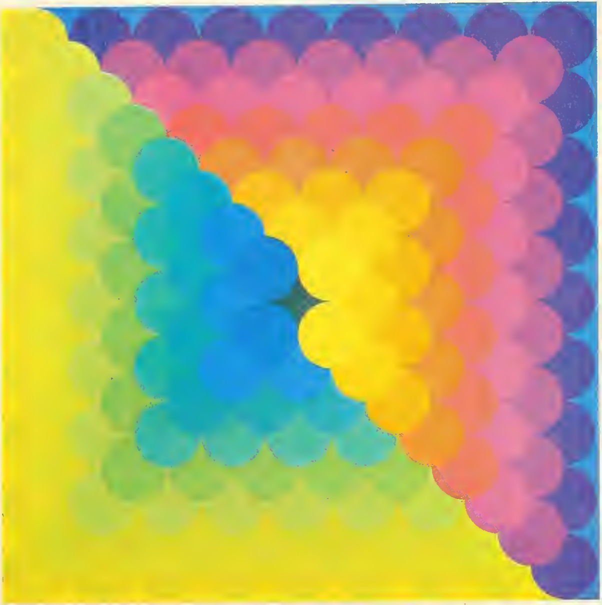

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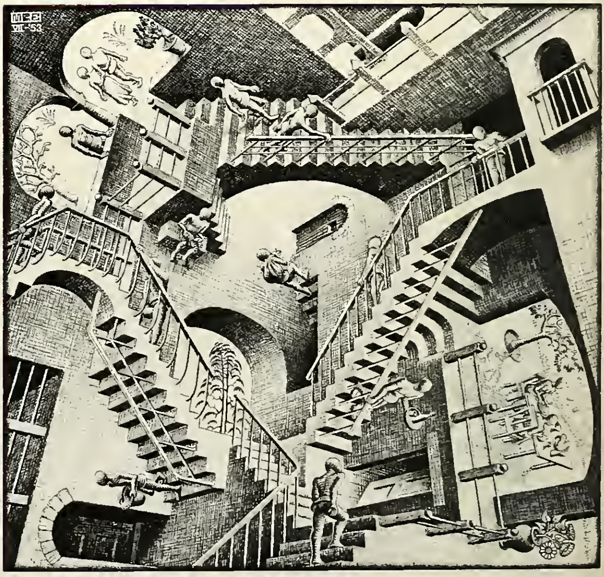

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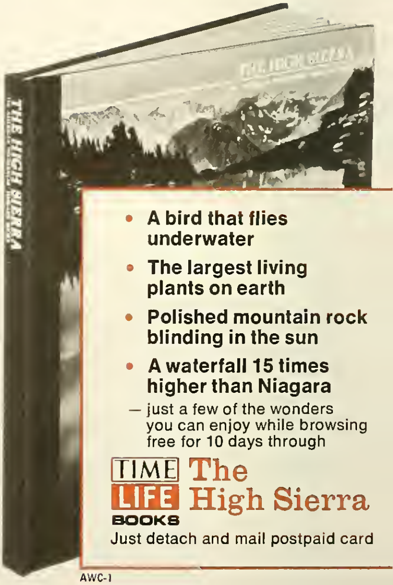

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Incorporating Nature Magazine
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Can well-fed, comfortable Americans even begin to comprehend the meaning of a society pushed to the utter limits of survival?

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98 Celestial Events
Thomas D. Nicholson

Cover: *The efficient and delicate radials of a sea worm decorate a coral reef near Curaçao. Story on page 40.*

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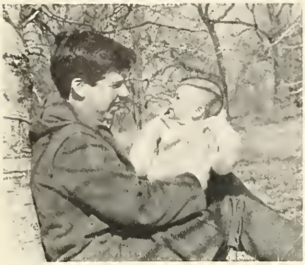
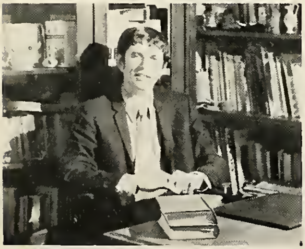


Stephen Jay Gould

As part of his involvement in the debate over differing theories of evolution, **Stephen Jay Gould** has written more than forty articles on the subject. An associate professor of geology at Harvard University's Museum of Comparative Zoology, Gould is presently writing a book on the relationship between ontogeny and phylogeny and continuing his field work in the Bahamas and Bermuda. He also finds time to sing in choral groups and attend operas.



William A. Douglass

Since 1963 **William A. Douglass** has been periodically living with Basques and studying their social organization and ethnohistory, both in this country and in Spain. Upon completing his doctorate in anthropology at the University of Chicago in 1967, Douglass became the coordinator of Basque Studies at the University of Nevada's Desert Research Institute. In 1969 his book *Death in Murelaga* was published by the University of Washington Press.

Meredith L. Jones

Meredith L. Jones's research in the biology of flowerlike sea worms has taken him to the reefs surrounding many tropical islands. His principal interest is the interrelationship of different sea worm species, the subject of an earlier *Natural History* article, "Complexities in the Substrate," May, 1963. Curator of worms at the Smithsonian Institution, Jones is pushing his studies of marine life on the Atlantic and Pacific coasts of Panama because the proposed construction of a sea-level canal requires background data to determine the effect of mixing marine life from the two oceans.

For the past sixteen years, **George M.A. Hanfmann** has taken part in the excavations and restorations of Sardis undertaken jointly by Harvard and Cornell Universities and the American Schools of Oriental Research. In addition to being field director of the ongoing Sardis Expedition, Hanfmann is a professor of fine arts and the John E. Hudson Professor of Archaeology at Harvard. Born in Russia in 1911, he came to this country in 1934, after having received his doctorate in archeology from the University of Berlin. Through his early interest in the Etruscans, he became involved in Anatolian archeology and the excavations of Tarsus, which subsequently led him to Sardis. Hanfmann has written numerous articles, notes, and reviews about archeology. His *Letters from Sardis*, which has just been published by Harvard University Press, is excerpted in this issue.

George M.A. Hanfmann

Jack Ward Thomas

Coauthors **Jack Ward Thomas** and **Ronald A. Dixon** are both doctoral candidates at the University of Massachusetts' Department of Forestry and Wildlife: Thomas in forestry, Dixon in wildlife biology. Both work for the U.S. Forest Service in Amherst. Thomas worked in his native Texas on wildlife management programs for eleven years and now leads a project for the Environmental Forestry Research Unit; Dixon is a wildlife research biologist.

Ronald A. Dixon

Donald F. Bruning, assistant curator of ornithology at the New York Zoological Society, has studied rheas for the past three years and is presently completing his doctoral thesis on these birds for the University of Colorado. Since 1966 he has participated in five expeditions for the study of bird and reptile life, including two to Argentina under the auspices of the New York Zoological Society for the study of the greater rhea.

Donald F. Bruning

Susan Schlee

The culmination of five years of research on oceanographic history, Susan Schlee's book, *The Edge of an Unfamiliar World*, was published in January by E.P. Dutton. Schlee, who is an independent investigator at the Marine Biological Laboratory in Woods Hole, has contributed several articles to *Natural History*, including "One Small Step for Science, One Good Meal for the Ship's Cat," October, 1972, and "Her Majesty's Fauna on the Bounding Main," October, 1971.

Letters

East Africa's Natural Heritage

To all of us who are interested in the future of East African wildlife and national parks, it has been apparent for many years that the ultimate threat to their future is not poaching but the inexorable pressure of human population growth and settlement. Norman Myers's article "The People Crunch Comes to East Africa" [January, 1973] puts the case with stark accuracy.

In his 1971 Environmental Message to Congress, President Nixon proposed that the nations of the world "agree to the principle that there are certain areas of such unique worldwide value that they should be treated as part of the heritage of all mankind and accorded special recognition as a part of a World Heritage Trust." This proposal of the President has now been embodied in the text of a convention agreed to at Paris last November, which is being submitted to the Senate for ratification. The critical situation of the East African parks gives this initiative a special urgency.

At the same time, as Myers forcefully points out, it is going to require far more than international expressions of concern and interest. The people of East Africa must themselves feel a personal stake in these areas. The African Wildlife Leadership Foundation (of which I was president from its founding until 1969, when I came back into government) was always sensitive to the fact that tourism as the main argument for conservation in East Africa did not fully take account of this need and, in fact, could even backfire. It was for this reason that we placed our major emphasis on education—first, professional training of wildlife and parks managers, then education of young Africans.

The essential need in East Africa and elsewhere is to integrate conservation and environmental programs generally with legitimate and reasonable aspirations for human well-being and development. I know of no simple solutions to this need. Last June's U.N. Conference on the Human Environment at Stockholm was a start at addressing this need internationally. With the new U.N. Environmental Secretariat scheduled to be headquartered at Nairobi, let us all hope that the objective of protecting the unique natural heritage of East Africa within the context of national development goals will receive new emphasis and support.

RUSSELL E. TRAIN
Chairman, President's Council on Environmental Quality

Energy Savings

Perhaps now that the ecological crusade is reaching flood tide and the realization is finally being brought home to Americans that our energy resources are not boundless and eternal, a fairly simple, logical, ecological, and energy-saving measure could have some chance of political success. I am referring to the national use of maximum daylight savings time. The energy savings that such a simple change in our living habits would produce could be astonishing.

There might be some minor inconveniences, but these would be more than offset by the billions of dollars worth of energy that would be conserved.

VINCENT MOORE, M.D.
La Mesa, California

Ecological Symbol

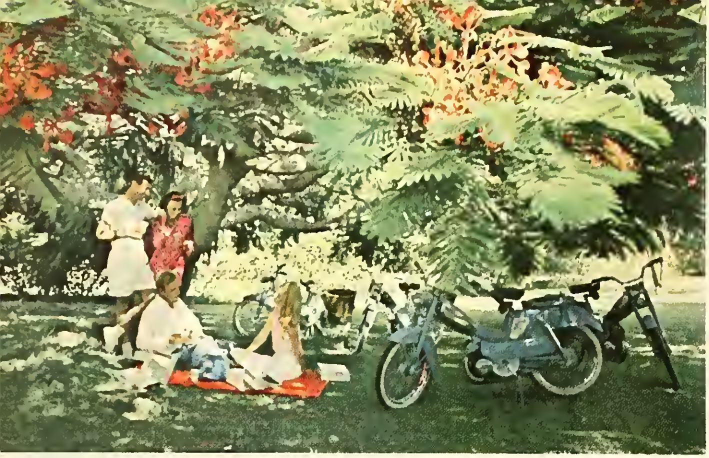
It is of great value for people today to be aware of such examples of environmental harmony as described by Christopher Williams in "Craftsmen of Necessity" [November, 1972], but it is vitally important that we see them as symbols rather than models. Too many people are trying to go "back to nature" or be "ecological" by building, for example, heavy timbered houses with interior wood paneling, wood siding, shake roofs, etc. In such structures, elegant and natural though they be, there is usually enough wood to frame three like-sized houses of more "conventional" construction. With mountain after mountain denuded by the hungry chain saw and millions of people inadequately housed, such practice is profoundly antiecological. Admirable and exciting as these examples of folk architecture are in their closeness to the earth, they must not be taken as models for our own building. They should rather be taken as symbols of a way of life, a consciousness for us to emulate.

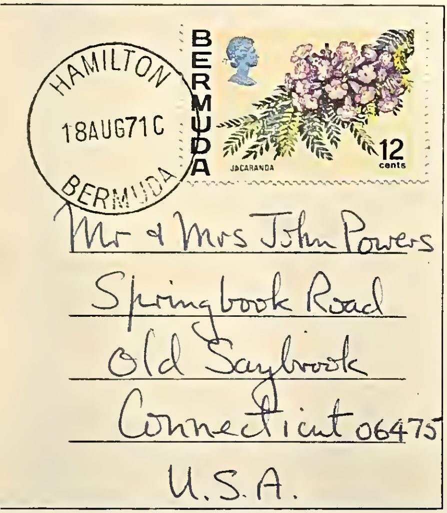
JOE SNYDER
Portland, Oregon

Fishers in Trees

I read your piece on the fisher in the January issue with great interest since this animal has fascinated me for a number of years. From 1940 through 1969 my wife and I would often spend two to four weeks in the fall with a trapper in Ontario, Canada. Part of our reason for these repeated visits, aside from the opportunity to live the trapping and hunting life for a while, lay in the special quality of the trapper himself. Roy Smith, who had trapped the territory for twenty years when we first met him, was a remarkable man, a cultivated bushman in the Thoreauvian sense. Among his admirable traits was the capacity for careful nature observation. Although I realize that the scientist must be most wary of "old husband's tales," I do believe that there are outdoorsmen whose observations can be taken as objective. I usually sort out such men by noting those who are willing to set down their observations without seeking to gild them with vague explanations or even the supposed motivations of wild creatures. Roy was as reliable an observer as I have ever met.

During his trapping runs, Roy had plenty of opportunity to learn





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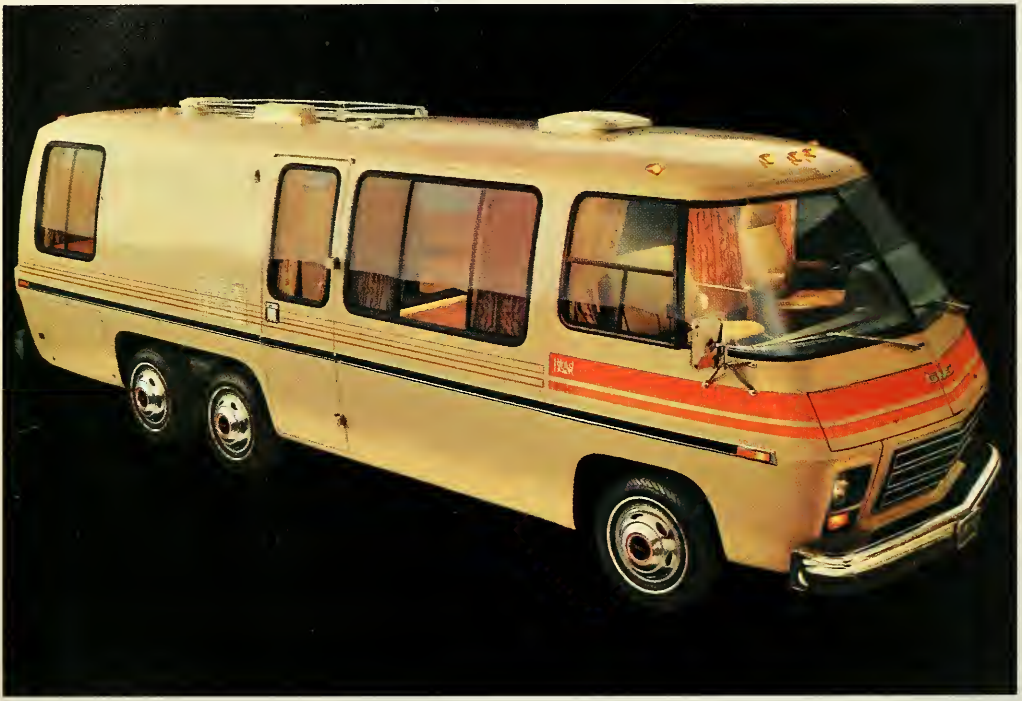

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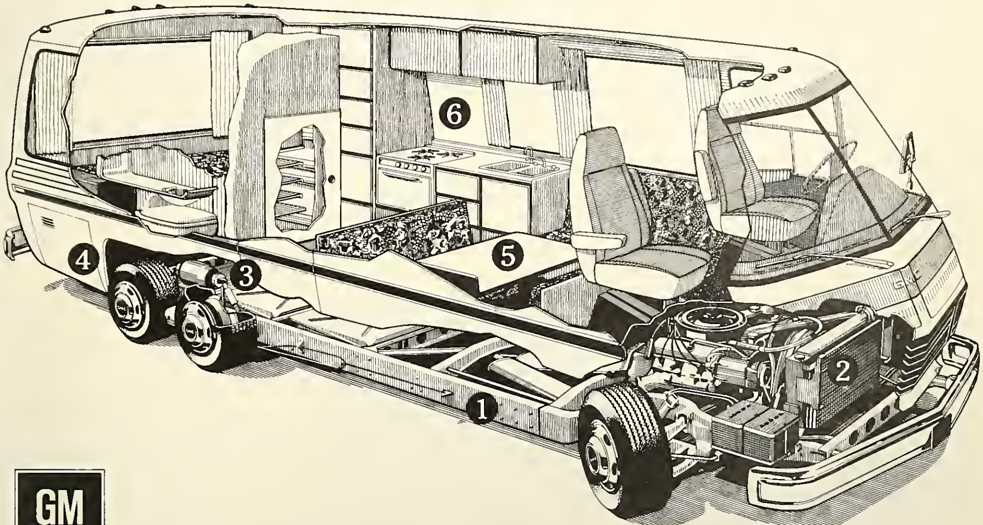

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much about the habits of the fisher, and I took notebooks full of notes over the years. Commenting on the fisher's prey, he often said that "the fisher's main food is the snowshoe hare, but I'll tell you he catches a lot of porcupines in his travels." His observations on the fisher's method of killing porcupines went as follows.

First making it clear that the fisher sometimes catches and kills porcupines on the ground, he explained that many times he discovered a fisher's track in the snow and, upon following it, had seen where the fisher had cut a porcupine track. "The fisher runs up and down the track a few times and then takes off in the direction the porcupine took." He then went on to say that sometimes the fisher would track the porcupine to a tree that the animal had gone up to feed. In these instances, "it is good-bye porcupine, for his fate is sealed." The action was always the same, he said, when the fisher caught a porcupine in a tree. "You'd see what remained of the porcupine, thrown out a dozen or more feet from the bole of the tree, and either the fisher's tracks coming away from the tree toward the porky when he'd come down or, more likely, the fisher tracks would take up where he jumped down out of the tree onto the snow."

Roy was convinced that in these instances the fisher delivered whatever disabling wound it gave the porcupine in the tree, for there would be no evidence of the porcupine defending itself on the ground or tracks of the fisher "bounding about, jumping in and out" as there would be if it killed it on the ground. The tracks around the remains of the porcupine seemed to be in each instance only those that the fisher would make as it worked on the dead rodent.

On one occasion in discussing the fisher–porcupine relationship, Roy said that it was no surprise to him that fishers could easily outmaneuver a porcupine in the tree considering "how nimble they are." He had seen a fisher in the treetops several times to gain this conclusion and once added. "Oh, they are at home in the trees; they even come down head first."

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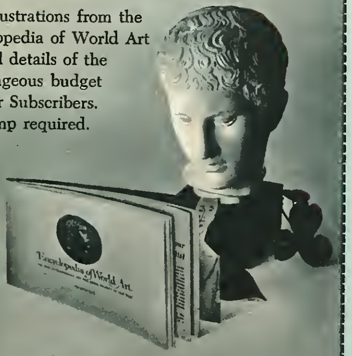

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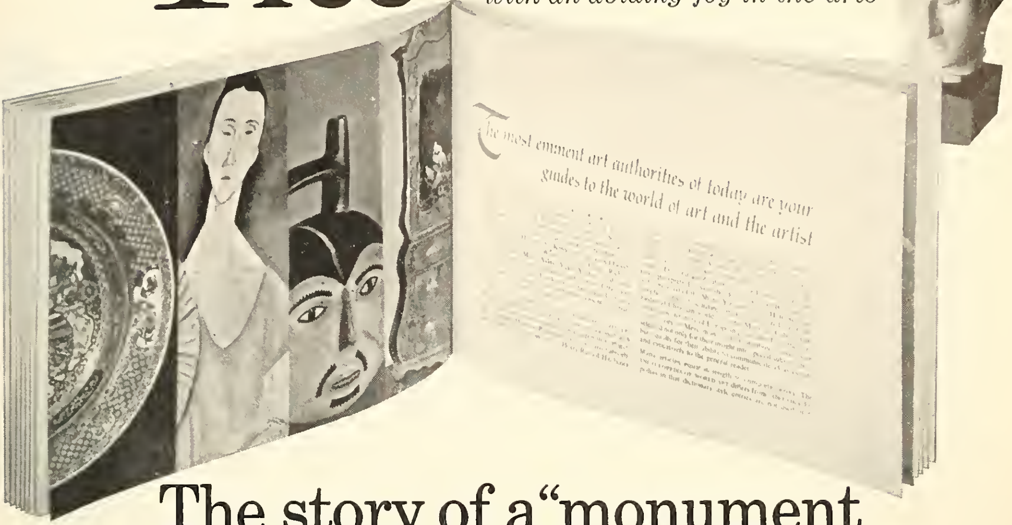
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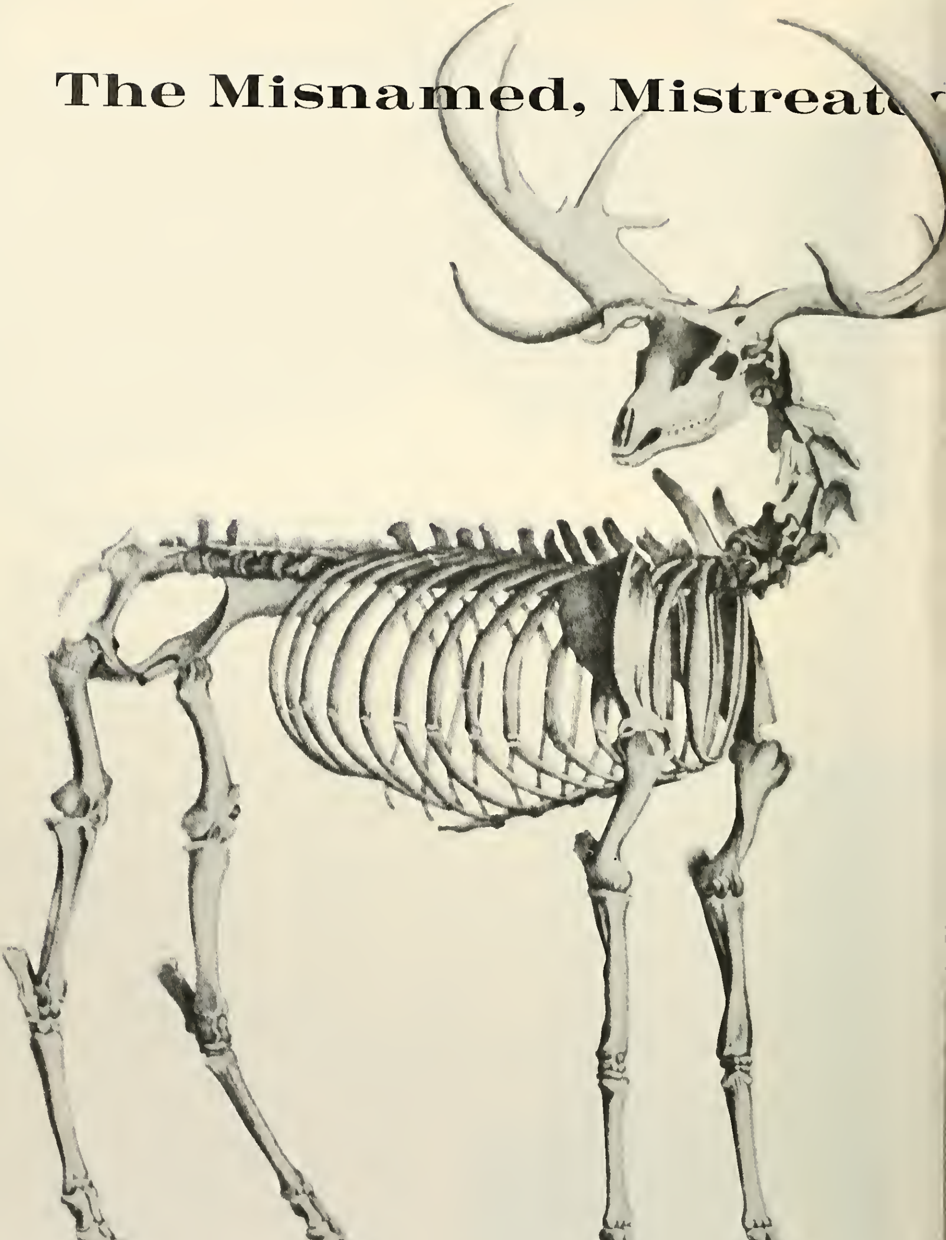

Model of Irish elk skeleton in Edinburgh Museum had a horse's pelvis and an abnormally straight backbone. The drawing is by G. Cuvier, 1825.

and Misunderstood Irish Elk

This extinct giant deer, for centuries the subject of argument between scientists and theologians, is an evolutionary symbol of nonviolence

by Stephen Jay Gould

> "Nature herself seems by the vast magnitude and stately horns she has given this creature, to have singled it out as it were, and showed it such regard, with a design to distinguish it remarkably from the common herd of all other smaller quadrupeds."
>
> *Thomas Molyneux,* 1697

The Irish elk, the Holy Roman Empire, and the English horn form a strange ensemble indeed. But they do share a common distinction—they have completely inappropriate names. The Holy Roman Empire, Voltaire tells us, was neither holy, nor Roman, nor an empire. The Irish elk was neither exclusively Irish, nor an elk. But it was the largest deer that ever lived. Its antlers were enormous; if we enlarge any other deer to the size of an Irish elk without changing its shape, its antlers will still fall far short of the "spacious horns" of the giant deer that so astounded Molyneux in 1697.

Although the *Guinness Book of World Records*—ignoring fossils—honors the American moose, the antlers of the Irish elk have never been exceeded or even approached in the history of life. Reliable estimates of their total span range up to 12 feet. This figure is all the more impressive when we recognize that, as in all other true deer, the antlers were probably shed and regrown annually.

Fossil antlers of the giant deer have long been known in Ireland, where they occur in lake sediments underneath peat deposits. Before attracting the attention of scientists, they had been used as gateposts and, in one instance, even as a temporary bridge to span a rivulet in County Tyrone. One story, probably apocryphal, tells of a huge bonfire made of giant deer bones and antlers in County Antrim to celebrate the victory over Napoleon at Waterloo. They were called elk because the European moose (an "elk" to Englishmen) was the only familiar animal with antlers that even approached those of the giant deer in size.

The first known drawing of giant deer antlers dates from 1588. Nearly a century later, Charles II, who reigned from 1660–1685, received a pair of antlers and, according to Dr. Molyneux, "valued them so highly for their prodigious largeness" that he set them up in the horn gallery of Hampton Court, where they "so vastly exceed" all others in size "that the rest appear to lose much of their curiosity."

Ireland's exclusive claim vanished in 1746 (although the name stuck) when a skull and antlers were unearthed in Yorkshire, England. The first continental discovery followed in 1781 from Germany, while the first complete skeleton (still standing in the museum of Edinburgh University) was exhumed from the Isle of Man in the 1820s.

We now know that the giant deer ranged as far east as Siberia and China and as far south as northern Africa. Specimens from England and Eurasia are almost always fragmentary, and nearly all the fine specimens that adorn so many museums throughout the world are from Ireland. The giant deer evolved during the glacial period of the last few million years and may have survived to historic times in continental Europe, but it became extinct in Ireland about 11,000 years ago.

"Among the fossils of the British empire," wrote James Parkinson in 1811, "none are more calculated to excite astonishment." And so it has been throughout the history of pa-

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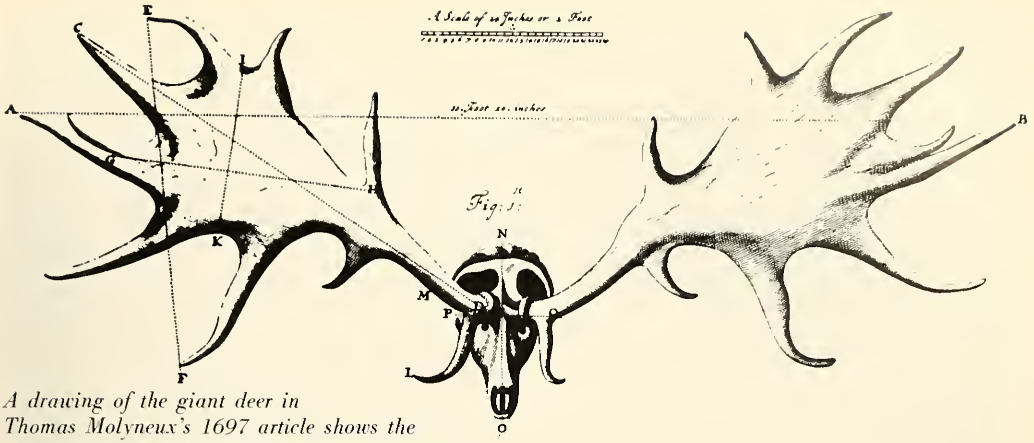

A drawing of the giant deer in Thomas Molyneux's 1697 article shows the antlers incorrectly rotated forward ninety degrees.

leontology. Putting aside both the curious anecdotes and the sheer wonder that immensity always inspires, the importance of the giant deer lies in its contribution to debates about evolutionary theory. Every great evolutionist has used the giant deer to defend his favored views. The controversy has centered around two main issues: (1) Could antlers of such bulk be of any use? and (2) Why did the giant deer become extinct?

Since debate has long centered on the reasons for the Irish elk's extinction, it is ironic that the primary purpose of Molyneux's original article was to argue that the deer must still be alive. Many seventeenth-century scientists maintained that the extinction of any species would be inconsistent with God's goodness and perfection. Dr. Molyneux's 1697 article, the first scientific description of the giant deer, begins: "That no real species of living creatures is so utterly extinct, as to be lost entirely out of the World, since it was first created, is the opinion of many naturalists; and 'tis grounded on so good a principle of Providence taking care in general of all its animal productions, that it deserves our assent."

Yet the giant deer no longer inhabited Ireland, and Molyneux was forced to search elsewhere. After reading travelers' reports of the American moose's antler size, he concluded that the Irish elk was the same animal; the tendency toward exaggeration in such accounts is apparently universal and timeless. Since he could not find either a figure or an accurate description of the moose, his conclusions are not as absurd as modern knowledge would indicate. Molyneux attributed the giant deer's demise in Ireland to an "epidemick distemper," caused by "a certain ill constitution of air."

For the next century arguments followed along Molyneux's line—to which modern species did the giant deer belong? Opinion was equally divided between the moose and the reindeer.

As eighteenth-century geologists unraveled the fossil record of ancient life, it became more and more difficult to argue that the odd and unknown creatures revealed by fossils were all still living in some remote portion of the globe. Perhaps God had not created just once and for all time; perhaps He had experimented continually in both creation and destruction. If so, the world was surely older than the 6,000 years that literalists allowed.

The question of extinction was the first great battleground of modern paleontology. In America, Thomas Jefferson maintained the old view, while Georges Cuvier, the great French paleontologist, was using the Irish elk to prove that extinction did occur. By 1812 Cuvier had resolved two pressing issues: by using minute anatomical descriptions, he proved that the Irish elk was not like any modern animal; and by placing it among many fossil mammals with no modern counterparts, he established the fact of extinction and set the basis for the geologic time scale.

Once the fact of extinction had been settled, debate moved to the time of the event: in particular, had the Irish elk survived the flood? This was no idle matter, for if the flood or some previous catastrophe had wiped out the giant deer, then its demise had natural (or supernatural) causes. Archdeacon Maunsell, a dedicated amateur, wrote in 1825: "I apprehended they must have been destroyed by some overwhelming deluge." A certain Dr. MacCulloch even believed that the fossils were found standing erect, noses elevated—the deer's final gesture to the rising flood, as well as their final plea: don't make waves.

If, however, they had survived the flood, then their exterminating angel could only have been the naked ape himself. Gideon Mantell, writing in 1851, blamed Celtic tribes; Hibbert implicated the Romans and the extravagant slaughters of their public games. Lest we assume that man's destructive potential was recognized only recently, Hibbert wrote in 1830: "Sir Thomas Molyneux conceived that a sort of distemper, of pestilential murrain, might have cut off the Irish elks. . . . It is, however, questionable, if the human race has not occasionally proved as formidable as a pestilence in exterminating from various districts, whole races of wild animals."

In 1846 Britain's greatest paleontologist, Sir Richard Owen, reviewed the evidence and concluded that the giant deer, in Ireland at least, had perished before man's ar-

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rival. By this time, Noah's flood as a serious geologic proposition had passed from the scene. What then had wiped out the giant deer?

Within 10 years of Charles Darwin's publication of the *Origin of Species* in 1859, virtually all scientists had accepted the *fact* of evolution. But the debate about causes and mechanisms was not resolved (in Darwin's favor) until the 1930s. Darwin's theory of natural selection requires that all evolutionary changes be adaptive—that is, that they be useful to the organism. Therefore, the anti-Darwinians searched the fossil record for cases of evolution that could not have benefited the animals involved.

The theory of orthogenesis became the touchstone for anti-Darwinian paleontologists, for it claimed that evolution proceeded in straight lines, which natural selection could not regulate. Certain trends, once started, could not be stopped even if they led to extinction. Thus, it was said that certain oysters coiled their valves upon each other until they sealed the animal permanently within; that saber-toothed tigers could not stop growing their teeth or mammoths their tusks.

But by far the most famous example of orthogenesis was the Irish elk. The giant deer had evolved from small forms with even smaller antlers. Although the antlers were useful at first, their growth could not be contained and, like the sorceror's apprentice, the giant deer discovered only too late that even good things have their limits. Bowed by the weight of their cranial excrescences, caught in the trees or mired in the ponds, they died. What wiped out the Irish elk? They themselves or, rather, their own antlers did.

In 1925 the American paleontologist R. S. Lull invoked the giant deer to attack Darwinism: "Natural selection will not account for overspecialization, for it is manifest that, while an organ can be brought to the point of perfection by selection, it would never be carried to a condition where it is an actual menace to survival . . . [as in] the great branching antlers of the extinct Irish deer."

Darwinians, led by Julian Huxley, led a counterattack in the 1930s. Huxley noted that as deer get larger—either during their own growth or in the comparison of related adults of different sizes—the antlers do not increase in the same proportion as body size; they increase faster, so that the antlers of large deer are not only absolutely larger but also relatively larger than those of small deer. For such regular and orderly change of shape with increasing size, Huxley used the term allometry.

Allometry provided a comfortable explanation for the giant deer's antlers. Since the Irish elk had the largest body size of any deer, its relatively enormous antlers could have been the simple consequence of an allometric relationship present among all deer. We need only assume that increased body size was favored by natural selection; the large antlers might have been an automatic consequence. They might even have been slightly harmful in themselves, but this disadvantage was more than compensated for by the benefits of larger size, and the trend continued. Of course, when problems of larger antlers outweighed the advantages of larger bodies, the trend would cease since it could no longer be favored by natural selection.

Almost every modern textbook of evolution presents the Irish elk as a model case in this light, citing the allometric explanation to counter orthogenetic theories. As a trusting student, I had assumed that such constant repetition was firmly based on copious data. Later I discovered that textbook dogma is self-perpetuating; therefore, three years ago I was disappointed, but not really surprised, to discover that this widely touted explanation was based on no data whatsoever. Aside from a few desultory attempts to find the largest set of antlers, no one had ever measured an Irish elk. Yardstick in hand, I resolved to rectify this situation.

The National Museum of Ireland in Dublin has seventeen specimens on display and many more, piled antler upon antler, in a nearby warehouse. Most large museums in western Europe and America own an Irish elk, and the giant deer adorns many trophy rooms of English and Irish gentry. The largest antlers grace the entranceway to Adare Manor, home of the Earl of Dunraven, in Ireland. The sorriest

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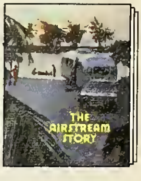
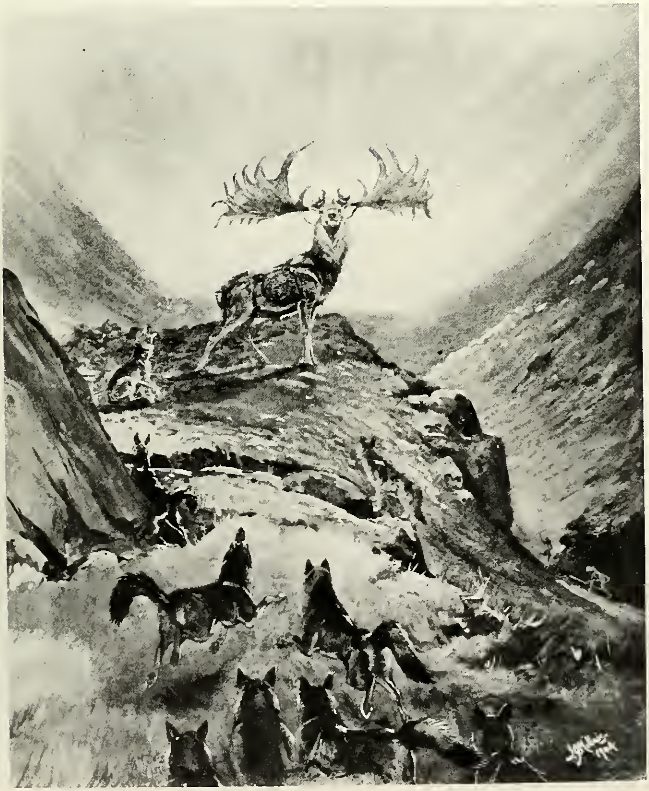


skeleton, also in Ireland, sits in the cellar of Bunratty Castle, where many merry and slightly inebriated tourists repair for coffee each evening after a medieval banquet. This poor fellow, when I met him early the morning after, was smoking a cigar, missing two teeth, and on the tines of his antlers, he carried three coffee cups. For those who enjoy invidious comparisons, the largest antlers in America are at Yale; the smallest in the world at Harvard.

To determine if the giant deer's antlers increased allometrically, I compared antler and body size. For antler size, I used a compounded measure of antler length, antler width, and the lengths of major tines. Body length, or the length and width of major bones, might be the most appropriate measure of body size, but I could not use it because the vast majority of specimens consist of only a skull and its attached antlers. Moreover, the few complete skeletons are invariably made up of several animals, much plaster, and, occasionally, ersatz (the first skeleton in Edinburgh once sported a horse's pelvis). Skull length therefore served as my measure of over-all size. This is not so bad a resolution as it may at first appear. Body length and weight depend strongly upon age and condition; these are extraneous factors with strong effects upon antlers that can easily confuse a primary correlation with size (measures for antler size can be corrected for age). The skull, however, reaches its final length at a very early age (all my specimens are older) and does not vary thereafter; it is, therefore, a good indicator of body size. My sample included 79 skulls and antlers from museums and homes in Ireland, Britain, continental Europe, and the United States.

Wolves and man hunt the Irish elk in a 1904 painting by J. G. Millais, but the giant deer was probably extinct in Ireland before man arrived.



My measurements showed a strong positive correlation between antler size and body size, with the antlers increasing in size two and one-half times faster than body size from small to large males. This is not a plot of individual growth; it is a representation for adults of different body size. Thus, the allometric hypothesis is affirmed. If natural selection favored large deer, then relatively larger antlers would appear as a correlated result of no necessary significance in itself.

Yet, even as I affirmed the allometric relationship, I began to doubt the traditional explanation—for it contained a curious remnant of the older, orthogenetic view. It assumed that the antlers are not adaptive in themselves and were tolerated only because the advantages of increased body size were so great. But why must we assume that the immense antlers had no primary function? Equally possible is the opposite interpretation: that selection operated primarily to increase antler size, thus yielding increased body size as a secondary consequence. The case for inadaptive antlers has never rested on more than the subjective wonderment born of their immensity.

Views long abandoned often continue to exert their influence in subtle ways. The orthogenetic argument lived on in the allometric context proposed to replace it. I believe that the supposed problem of "unwieldy" or "cumbersome" antlers is an illusion rooted in a notion now abandoned by students of animal behavior.

To nineteenth-century Darwinians, the natural world was a cruel place. While modern scientists tend to measure the benefits of evolution in terms of successful reproduction, last century's Darwinians assessed evolution in terms of battles won and enemies destroyed. In this context, antlers were viewed as formidable weapons to be used against predators and rival males. In his *Descent of Man* (1871), Darwin toyed with another idea: that antlers might have evolved as ornaments to attract females. "If, then,

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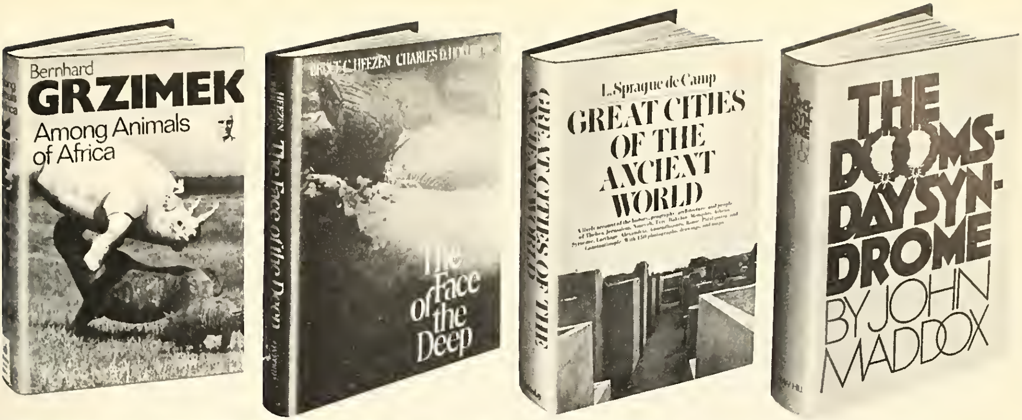

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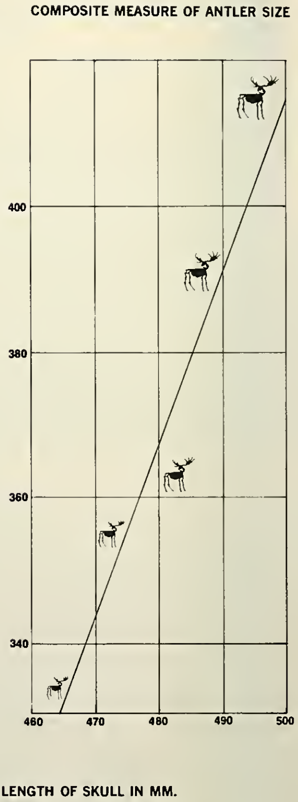
the horns, like the splendid accouterments of the knights of old, add to the noble appearance of stags and antelopes, they may have been modified partly for this purpose." Yet he quickly added that he had "no evidence in favor of this belief," and went on to interpret antlers according to the "law of battle" and their advantages in "reiterated deadly contests." All early writers assumed that the Irish elk used its antlers to kill wolves and drive off rival males in fierce battle. To my knowledge this view has been challenged only by the Russian paleontologist L. S. Davitashvili, who in 1961 asserted that the antlers functioned primarily as courtship signals to females.

Now, if antlers are weapons, the orthogenetic argument is appealing, although I must admit that ninety pounds of broad-palmed antler, regrown annually and spanning twelve feet from tip to tip, seems even more inflated than our current military budget. Therefore, to preserve a Darwinian explanation, we must invoke the allometric hypothesis in its original form.

But what if antlers do not function primarily as weapons? Modern studies of animal behavior have generated an exciting concept of great importance to evolutionary biology: many structures previously judged as actual weapons or devices for display to females are actually used for ritualized combat among males. Their function is to prevent actual battle (with its consequent injuries and loss of life) by establishing hierarchies of dominance that males can easily recognize and obey.

Antlers and horns are a primary example of structures used for ritualized behavior. They serve, according to Valerius Geist, as "visual dominance-rank symbols." Large antlers confer high status and access to females. Since there can be no evolutionary advantage more potent than a guarantee of successful reproduction, selective pressures for larger antlers must often be intense. As more and more horned animals are observed in their natural environment, older ideas of deadly battle are yielding to evidence of fighting in ways clearly designed to prevent bodily injury or of purely ritualized assertion of dominance without body contact. This has been observed in red deer by Beninde and Darling, caribou by Kelsall, and in mountain sheep by Geist.

As devices for display among males, the enormous antlers of the Irish elk finally make sense as structures adaptive in themselves. Moreover, as R. Coope of Birmingham University pointed out to me, the detailed morphology of the antlers can be explained, for the first time, in this context. Deer with broad-palmed antlers tend to show the full width of their antlers in display. The modern fallow deer (considered by many as the Irish elk's nearest living relative) must rotate



Irish elk specimens showed a strong correlation between body and antler size, with the horns increasing two and one-half times as fast as the body in an allometric growth relationship.

its head from side to side in order to show its palm. This would have created great problems for giant deer, since the torque produced by swinging ninety-pound antlers would have been immense. But the antlers of the Irish elk were arranged so ingeniously that it only had to bow its head once to display all facets of its antlers. When the deer was looking straight ahead, the palm was fully displayed. With its head down, both the length of the giant deer's antlers and the strength of their tines were strikingly evident. (In any case the tines could hardly have been effective in battle since they pointed backwards and could not be directed toward a facing enemy unless the deer held its head down between its legs.) Therefore, both the unusual configuration and the enormous size of the antlers can be explained by postulating that they were used for display rather than for combat.

If the antlers were adaptive, why did the Irish elk become extinct (at least in Ireland)? The probable answer to this old dilemma is, I am afraid, rather commonplace. The giant deer flourished in Ireland for only the briefest of times—during the so-called Alleröd interstadial phase at the end of the last glaciation. This period, a minor warm phase between two colder epochs, lasted for about 1,000 years, from 12,000 to 11,000 years before the present. (The Irish elk had migrated to Ireland during the previous glacial phase when lower sea levels established a connection between Ireland and continental Europe.) While it was well adapted to the grassy, sparsely wooded, open country of Alleröd times, it apparently could not adapt either to the subarctic tundra that followed in the next cold epoch or to the heavy forestation that developed after the final retreat of the ice sheet.

Extinction is the fate of most species, usually because they fail to adapt rapidly enough to changing conditions of climate or competition. Darwinian evolution decrees that no animal shall actively develop a harmful structure, but it offers no guarantee that useful structures will continue to be adaptive in changed circumstances. The Irish elk was probably a victim of its own previous success. ■

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"You have to be brutally frank with some governments; you have to push them into using it," remarked plant geneticist Norman E. Borlaug during an interview shortly after he won the Nobel Prize. Dr. Borlaug was talking about the introduction of the high-yield, semidwarf wheat, the so-called miracle seeds of the Green Revolution. It was for the development of those seeds that he had won his prize. He was also deeply involved in promoting their use throughout the world.

At the same time that Borlaug was being interviewed, in January, 1971, U.S. government food experts were claiming that the battle against hunger and malnutrition in the underdeveloped world would soon be won. High-yield varieties of rice and wheat had provided four consecutive years of record harvest in India and Pakistan. The miracle seeds had ended the need for rice imports in the Philippines, and President Suharto was predicting self-sufficiency for Indonesia.

"It doesn't do any good to get 10 or 15 percent yield increases," Borlaug continued. "They won't listen to you. You have to throw the long bomb. You have to make a 100 or 200 percent gain to change their old worn-out practices."

As I predicted in this column last June, the Green Revolution has not brought any significant respite from hunger and malnutrition in Asia. Despite a total of more than 50 million acres planted in high-yield varieties of rice and wheat, grain production fell to dangerously low levels throughout Asia last year.

In the Philippines more than 50 percent of the acreage devoted to rice was planted in high-yield varieties, yet output last year fell 5 percent below 1971, which was already down 3 percent from 1970. Following typhoons, floods, and civil disorders, Ferdinand Marcos instituted a dictatorship. The rice shortage was one of the fundamental causes of this crisis.

India also may be on the verge of a disaster. By the end of 1972, news sources in Delhi, Calcutta, and Poona were reporting crop failures and famines in four states: Maharashtra, Rajasthan, Gujarat, and Mysore. Some 33 million people were already affected. Speakers at the eleventh regional conference of the Food and Agricultural Organization in New Delhi last November bluntly declared that the high-yield varieties had not solved Asia's food problem.

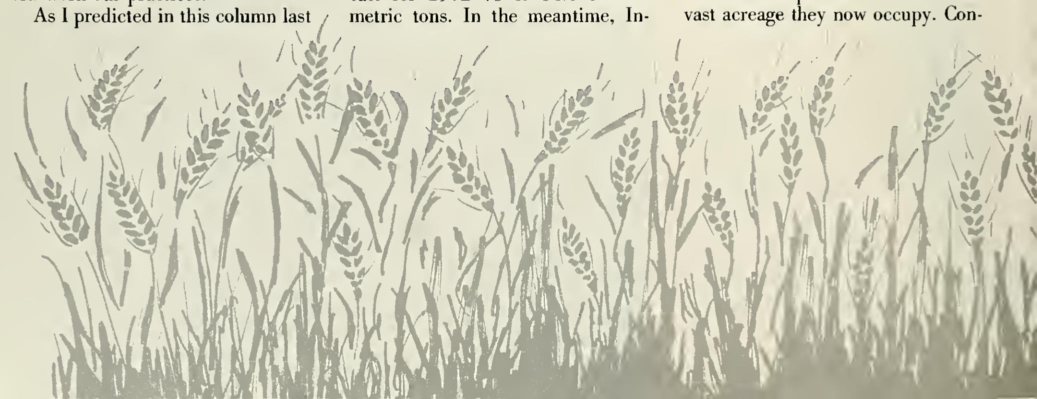
India's plight can be seen in figures recently presented by Kenneth Murray and Emanuel McNeil of the Grain and Feed Division of the U.S. Foreign Agricultural Service. Total Indian grain production went from 68.5 million metric tons in 1960–61 to a high of 92.8 million metric tons in 1970–71. The forecast for 1972–73 is 84.0 million metric tons. In the meantime, India's population has grown from 440.3 million to 570 million.

On a per capita basis, therefore, India's grain production has fallen below the levels of 1960–61, which was before the Green Revolution began. India produced 0.1556 metric tons per person then versus 0.1473 metric tons per person now. Even comparing 1972–73 with the worst drought year in past decades, total per capita grain production has improved less than 10 percent.

In each of the affected regions, government experts are blaming the deficits on unusual weather conditions—either too much or too little rain. But erratic monsoons, tropical storms, floods, and droughts are nothing new. These are precisely the conditions that must somehow be met and overcome to improve on the "old worn-out practices."

The main problem with the miracle seeds is that they are engineered to outperform native varieties only under the most favorable ecological conditions and with the aid of enormous amounts of industrial fertilizers, pesticides, insecticides, fungicides, irrigation, and other technical inputs. Without such inputs, the high-yield varieties perform no better—and sometimes worse—than the native varieties of rice and wheat, especially under adverse soil and weather conditions.

Even when the technical inputs are applied in sufficient quantities, certain ecological problems arise, which seem not to have been given adequate consideration before the seeds were "pushed" out onto the vast acreage they now occupy. Con-



by Marvin Harris

version to high-yield varieties creates novel opportunities for plant pathogens, pests, and insects. The varieties also place unprecedented stress upon water resources. In the Philippines, for example, tungro rice virus, which was never a serious problem in the past, reached epidemic levels in 1970 and 1971, when more than half of all the rice acreage had been planted with high-yield varieties. I suspect that the modification of natural drainage patterns to provide extra water for paddies with high-yield plants contributed to the severe flooding that accompanied the typhoons in the summer of 1972.

In Pakistan tens of thousands of electrically operated tube wells have been drilled to provide water for high-yield wheat. Tube well irrigation is already lowering water tables and increasing the salinity of the soil. One might think that a tube well farmer would at least be able to come out ahead during a drought. But this has not necessarily been the case. Reduced water flows in the major rivers have led to cutbacks in hydroelectric production. Without electricity the tube well farmers cannot pump water up to their fields. Moreover, the loss in hydroelectric output has impaired chemical fertilizer production.

Of course, every man-made technological disaster has its man-made technological solution. But the peasant smallholders of Asia cannot meet the costs of spiraling technical inputs needed to avoid disaster. The Green Revolution inevitably widens the gap between landowners who have the credit and the know-how to keep up with the technological solutions and the peasant smallholders who stand to lose their land when the unanticipated ecological side effects appear.

The Green Revolution in Indonesia is a case in point. According to Prof. Richard Franke of the Department of Anthropology at Montclair College, that rice-growing country has already had three distinct phases of Green Revolution, all of them failures. In Green Revolution I, the government gave loans to individual peasants for the purchase of high-yield seeds and expensive fertilizers. Not knowing what the price of rice would be at the end of the year, many peasants calculated that they would do better selling the fertilizer on the black market rather than putting it on their fields. They also skimped on the insecticides, hoping to save some for future use. Some farmers had no choice but to sell the entire high-yield packet because it arrived in their villages after the planting season. Corruption and mismanagement among officials charged with distributing the packets created additional problems. With large number of peasants defaulting on their loans, the government abruptly halted the program in 1968.

Green Revolution II began in 1969. Having lost faith in its own ability to control the distribution of the technical inputs, the government contracted with large international corporations to use their know-how to push the high-yield seeds in the villages. The govern-

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ment agreed to pay $54 for each hectare that the corporations converted to miracle rice. The corporations proceeded by subcontracting with Indonesian firms. Peasants were given loans that had to be repaid with one-sixth of the rice harvest; the army was supposed to collect this one-sixth and use it as a salary supplement for government employees.

To make certain that the prescribed amounts of insecticides were applied at the scheduled time, the corporations hired planes and pilots to spray from the air. The principal insecticide used was Demicon 100, produced by CIBA, a chemical corporation that happened to be the program's largest contractor. In 1969–70, CIBA, Mitsubishi, Hoechst, and other corporations were bringing Green Revolution II to about 2,471,000 acres in densely populated areas of Java, where the average farm was an acre in size and where 30 percent of the population owned no land at all.

The schedule for aerial spraying was fixed at regional headquarters, and it was up to the individual farmer to make sure that he was ready when the plane came over. Some peasants who did not want their lands sprayed kept moving the ground markers around to decoy the planes. Although CIBA denied charges that Demicon 100 was responsible for the death of children and water buffalo, everyone seems to agree that the spray was killing off the fish in the fishponds. The Indonesians rely on these fish for most of their protein. (Demicon 100 had already been implicated in a great Rhine River fish kill.)

Human duplicity finally put an end to Green Revolution II. Peasants underreported their harvests in order to lower the amount of rice they would have to hand over to the army. At the same time, local army officers in charge of collecting the rice overestimated how much had been produced in order to enlarge their personal cut of the one-sixth due the government. No one could determine if production had actually increased or decreased. The government soon discovered, however, that it was paying CIBA more than two dollars for every one dollar's worth of rice that the army said it was getting from the peasants. According to Gary E. Hansen, a research associate at the Technology and Development Institute, East-West Center, Honolulu, rice produced with CIBA was costing the government $305 a ton when the world market price was only $130 a ton. Now that's what I call a "long bomb."

Green Revolution III began in 1970 and is still going on. The government ships the seeds, fertilizers, and insecticides to local warehouses. Peasants take out low-cost loans and use the inputs as they see fit. Franke studied the effects of this program in a village where ecological conditions were optimal for the success of the high-yield varieties and found that actual yield increases of up to 70 percent over native varieties were being achieved.

Yet Franke discovered that only about one-fifth of the farming households had joined the program. As predicted, the chief beneficiaries were the households that were already better off than average and that had no labor debts to pay off. For the majority of farming households, the 70 percent productivity increase was not sufficient to make any real difference in their class position since they did not own enough land and would have to continue working for somebody else in order to get through the year. Traditionally, poor families in Franke's village make ends meet by working for well-to-do patrons who lend them money to buy food. The patrons are not eager for their clients to get out of debt because they need cheap labor for their large paddy holdings; on the other hand, the clients are afraid to break off relations because they fear being left on their own during a drought or family crisis.

Elsewhere in Indonesia, Green Revolution III is encountering ecological problems. A combination of political, economic, and ecological factors must be at work in the latest crisis. Whatever the precise cause, rice prices have trebled in recent months, and the government has already imported 1.5 million tons of rice and is looking around for more.

You have to be brutally frank with some experts, you have to push them into realizing it: the Green Revolution is a hoax.

Columnist Marvin Harris teaches anthropology at Columbia University.

Photo by Louise Bucknell

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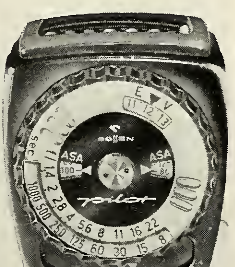

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by Arthur W. Galston

Plant Cancer

In plants, too, cells may suddenly break away from the constraints of normal, healthy growth

The orderly development of any multicellular organism, whether plant or animal, depends on a system of controls and mutual restraints among the different organs and even the different cells within each organ. How a fertilized egg develops into a complex organism, such as a rabbit or a tomato plant, is still a largely unsolved mystery, involving the complex processes of cellular differentiation. Molecular biologists have recently given us some insights into the events governing the emergence of differences among previously similar cells.

What seems to be involved is a regulated switching-on of some of the genes in the cell; these genes, through the production of specific messengers, then govern the production of specific proteins, including enzymes that catalyze the basic biochemical reactions of the cell. It can easily be imagined that different assemblies of switched-on genes can lead to the production of different populations of enzymes, and thus to cells differing ultimately in form, chemistry, and function. The key to the differentiation process, according to this theory, would be the master mechanism that decides which genes in a particular cell will be switched on.

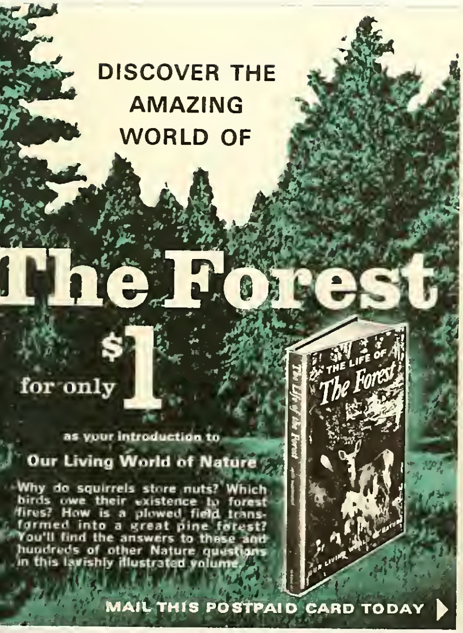
It has now been shown, in both plants and animals, that most—if not all—cells of an organism have the same total assembly of genes. Thus, a whole carrot plant can be reconstituted from an individual carrot root cell if the cell is cultured in an appropriate medium. Similarly, cells from the intestines of a toad, when injected into an egg cell whose own nucleus has been removed, can preside over the formation of a normal animal. This means that cellular differentiation is not irreversible and that cells with certain morphological and chemical characteristics can ultimately assume different characteristics. It all depends on which genes within the cells are switched on, which off.

What keeps a gene switched off? Probably its DNA is being covered by another large molecule, which prevents the gene from forming its messenger RNA. Such large repressor molecules are, at least in the bacteria, proteins that have a specific affinity for a particular gene.

Anything that removes the repressor from the gene has the effect of switching it on, and is called an inducer. Among the best-known inducers are the comparatively small molecules known as hormones. In both plants and animals, hormones migrate from the cells in which they are synthesized to some target tissue. There the hormones either stimulate the cells to new biochemical activities or switch off other activities. This system of mobile inducer hormones is one of the most powerful techniques used by plants and animals to insure orderly, balanced development. If cells of part of a plant are dependent on a substance produced by cells of another part, then the development of the two parts must proceed together.

In a plant, a proper balance of roots, stems, and leaves is maintained by a combination of nutritional and hormonal interactions. Roots absorb water and minerals from the soil and send these essential materials to leaves and stems; conversely, leaves produce photosynthetic materials and send them to stems and roots. This nutritional interdependence guarantees a proper balance between root mass and leaf mass. If a root system is too small, leaves and stems would be deficient in water and minerals. And if a leafy apparatus is too small, the stems and roots would starve. Superimposed on this gross nutritional control is a finer hormonal control; for example, roots produce hormones essential for leaf growth and maintenance, young leaves produce hormones essential for stem and root growth, and cells in the stem tips can influence the growth rate of other stem cells far removed from the tips.

Sometimes, this orderly system of controls is disturbed, and the organism develops abnormal growths. Galls grow on oaks and other plants when insects lay eggs there and the larvae develop within the plant tissue. We assume that the insect produces substances that regulate growth and alter the harmonious integration of plant tissues into their normal structures. Other malformations can be produced by bacteria; one causes witches'-broom by preventing the normal elongation of stem internodes, another causes clubroot in such plants as cabbage, and a third bacterium can cause the appearance of malignant tumors



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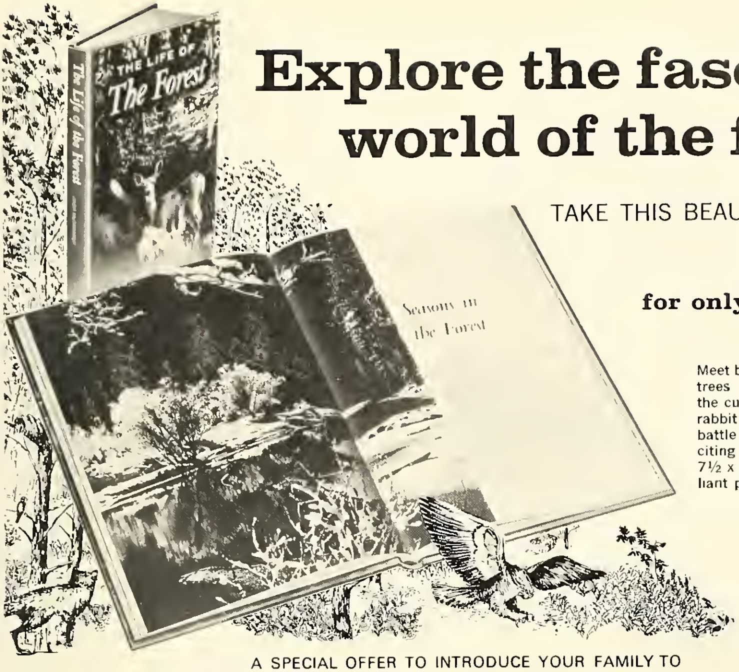

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known as crown galls. This last plant disease is especially interesting because of its resemblance to animal cancer.

To induce a crown gall, one must first wound the plant. Then virulent cells of *Agrobacterium tumefaciens* must be introduced into the wound. After about two to three days, the cells near the wound have been invaded by the bacterium and transformed into a malignant tumor. These tumors continue to grow and, unlike normal plant organs, their growth does not come under the hormonal control of any other tissues. The cells of the crown gall seem to circumvent the normal controls by producing by themselves all the hormones they need for growth. We thus assume that the bacterium in some way switches on previously inactive genes, and that the cancer-like growth occurs because cells gain a new ability to synthesize their own growth hormones.

After some time, the crown gall disease becomes systemic. New tumors grow at other locations on the plant, generally in strained positions such as the angles between the leaves and the stem. These secondary tumors may also grow to very large size, but they differ from the primary tumors in one important respect: they apparently contain no bacteria. Despite the absence of the bacterium that initially caused the disease, these secondary tumors are as malignant as the primary tumors. If either secondary or primary tumors are removed from the diseased plant and grafted onto a normal plant, other tumors will form on the plant. This makes the analogy with animal cancer rather complete; the bacterium is not the true cause of the malignancy, but only the agent that introduces the true infective principle into plant cells.

Why do these cancerous growths occur? What is the Tumor Inducing Principle (TIP) that so many researchers are trying to discover? We still do not know. It may be connected with a virus (bacteriophage) present in virulent strains of bacteria. Once released into the plant cell, this virus may replicate and spread throughout the plant, causing the symptoms of the disease. While the nature of TIP is uncertain, we are gaining insights into how it operates in plants. It appears to cause affected cells in stems to

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produce large quantities of such hormones as auxins and cytokinins, which stem cells normally obtain from other parts of the plant. When crown gall cells are excised from the plant and grown in pure cultures, they do not require additions of these hormones, as do normal cells. The cancerous cells apparently have many genes switched on by TIP, so that they now have many more capabilities to produce hormones than normal, partially repressed cells. They also have abnormally leaky membranes and lose much material from their cells into the surrounding medium.

The introduction of a cancerous crown gall condition to a healthy plant is neither an all-or-none phenomenon nor is it irreversible. During the crucial two- to three-day induction period after the initial wounding, the onset of the disease may be partly or completely prevented by "pasteurizing" the plant at slightly elevated temperatures. This treatment seems to inactivate the TIP at a crucial stage of the invasion. Once the disease has set in, it cannot be further prevented by the high temperature treatment. Also, if a weakly induced crown gall is grafted successively to several rapidly growing normal host plants, the gall tissue gradually reverts to a more and more normal growth condition. These experiments indicate that the state of the tissue involves a competition between normal and TIP-induced biochemical events: whichever predominates determines whether the cell will develop a normal or a tumorous growth habit.

This finding has led some researchers to propose that cancer should not be treated by applying growth-retarding chemicals, such as the chemotherapeutic agents now used, but rather growth-promoting chemicals that, by favoring the development of normal components, will swamp out the malignant growth. Whether or not this notion is true, crown gall and other plant tumors are interesting model systems for the study of cancer and offer important insights into the mechanisms that control normal growth and development of all living organisms.

Columnist Arthur W. Galston teaches biology at Yale University.

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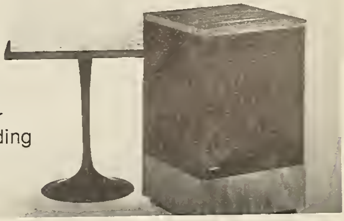

Lonely Lives Under the Big Sky

Roaming the high country of the American West, Basque sheepherders stir envy and dreams of escape in frustrated city dwellers; for the Basques, the isolation is often a desperate ordeal

by William A. Douglass

The Basque sheepherder of the American West has become a romanticized figure in popular literature. For those whose lives are dominated by urban pressures and ills, his life-style holds a primitivistic attraction; the thought of a solitary existence played out against spectacular mountain scenery lends itself to escapist dreams.

This mystique has developed through a one-sided view of the Basque sheepherder's life-style. Along with the beauty of his environment, the freedom from the irritations of urban life, and the seemingly uncomplicated task of caring for a band of sheep, there is also the necessity of enduring months of boredom and loneliness. In the American West, sheep raising is characterized by transhumance. Under this system, sheep bands are summered in the remote high-mountain country and wintered in the low, arid, and sparsely populated valleys. Twice a year the sheep traverse as much as several hundred miles between these ranges. Today some outfits truck their animals, but many still trail them, and in this instance the herders cover the entire distance on foot and horseback.

Constantly exposed to the physical elements, the herder must possess considerable self-reliance and endurance. As guardian of the sheep band, he is responsible for an asset worth many thousands of dollars. On the open range the sheep band is exposed to such predators as coyotes, lynx, and occasionally, mountain lions and bears, and the herder must be continually alert. There is also the danger of poisoning from toxic plants and bad water. Disease can strike, or a part of the band may wander off during a blizzard or when trailing through rugged country. At the same time, the herder lives in almost unbroken social isolation, and the nature of the occupation practically rules out the intimacies of family life.

Because labor shortages have always been endemic to this low-status, low-paying industry, the willingness of Basques to migrate from Spain and France and enter the occupation continues to be a major factor in the sheep industry's growth. Speaking a language that cannot be shown definitively to share common roots with any other human tongue, the Basques are regarded as the mystery people of Europe, an image that is heightened by imprecise knowledge of their origins.

Basque involvement in the open-range sheep industry dates from the days of the 1849 California gold rush. There were several hundred

RICHARD L

Basques in the ranks of the fortune seekers; many came directly from Argentina and Uruguay, where thousands of Basque immigrants had been livestockmen during the first half of the nineteenth century. In the 1850s and 1860s many of the Basque gold prospectors, notably those who had formerly lived in South America, left the mining camps and entered the nascent sheep and cattle industries of southern and central California.

By the 1880s the Basques had established a reputation as the finest sheepmen in the American West, and by the first decade of the twentieth century a few Basques had become prominent sheep ranchers with impressive herds and private landholdings. Others worked as herders and were the preferred employees in Basque and non-Basque sheep outfits alike, often replacing other immigrant or American Indian sheepherders. And finally, the Basques were the most prominent ethnic group in the ranks of the itinerant sheep outfits, which were referred to by their detractors as "tramp bands."

The itinerant sheep outfit was a one- or two-man operation requiring minimal capitalization. The shepherd-owner simply acquired about a thousand sheep, a pack animal, a tent, bedroll, and grubstake, then moved about the public lands searching for available pasturage. Most of the range was under federal ownership and as a part of the public domain, was legally open to all on a first-come basis. The legalities of the matter notwithstanding, competition for public pasturage and water among the itinerants themselves and between the itinerants and the settled cattle and sheep ranchers was at times fierce. On occasion, competition turned into conflict, and the resulting confrontations provided copy to the newspapers, litigation to the courts, and substance to the sheepman versus cattleman legend.

That Basques were the most numerous element in the ranks of the itinerant sheepmen exacerbated the situation. Each year thousands of Basque males, for the most part young and single, emigrated from Europe to replace those who had returned or who had purchased their own bands. Most entered the West with the intention of returning to the Old World after acquiring substantial capital. Few were willing to remain sheepherders for long, but rather, expected to become sheep owners as quickly as possible. With little interest in a future in this country, the budding Basque sheep entrepreneur was loath to invest in land; instead he sought to increase the size of his band. As he did so, he required additional herders and camp tenders and would send to Europe for kinsmen or fellow villagers. Frequently, the newcomers would take part of their wages in ewes, running their own animals alongside those of their kinsman-employer. They usually did this for three or four years, until they had

BILL BELKNAP-RAPHO GUILLUMETTE

sufficient animals to form an independent band. At this point the sheepherder would "hive off" his new outfit, striking out in search of fresh pasturage.

Since the owner of the parent outfit more often than not planned to return eventually to the Basque country, he was more interested in the short-term fluctuations of the lamb and wool markets than in the long-range prospects of the American sheep industry. He might therefore assist many kinsmen and fellow ethnics to become itinerant operators without giving much thought to the consequences of overgrazing.

As a result, American ranchers held a dim view of Basques. The ubiquitous Basque itinerants were depicted as foreign usurpers of American resources, opportunists who bled the economy of the American West of wealth that was sorely needed for local development. Their presence inflamed passions and stimulated anti-Basque sentiments, rhetoric, and eventually, legislation.

In the 1890s and early 1900s competition with the itinerants prompted many western ranchers to join eastern conservationists in supporting legislation to create the na-

RICHARD LANE

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A sheepherder, far left, leads his band to the lowlands, where he will find companionship for the winter. The stone pile, left, attests to the sheepherders' attempts to cope with loneliness on the high summer range, while tree carvings in aspen groves are the personal marks left by Basque herders over the years.

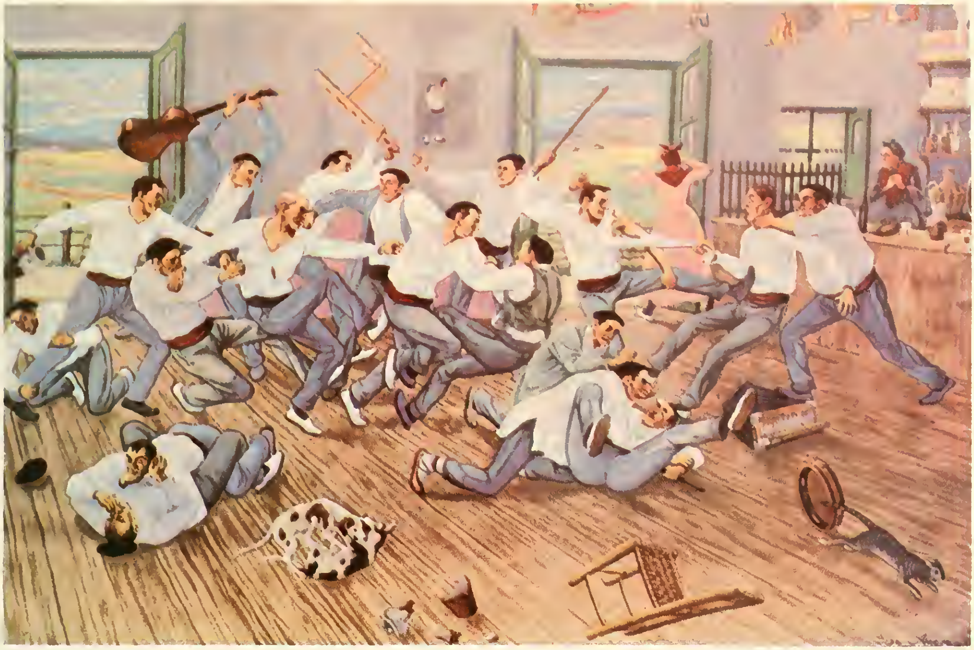
BILL BELKNAP-RAPHO GUILLUMETTE

Basque hotels, bars, and restaurants are scattered throughout the West's sheep-raising areas. During the short spring lambing and shearing season and the fall shipping period, sheepherders congregate for traditional Basque dances and festivities.

tional forest system. This system controlled access of livestock to the summer ranges in the newly established national forests of the high-mountain country. Significantly, grazing applications were reviewed by local boards of settled ranchers who made both ownership of private land and United States citizenship conditions for approval. In 1934 the Taylor Grazing Act brought most of the remaining public domain under grazing regulations. This legislation specifically excluded both the landless and aliens from use of the range. Furthermore, passage of a series of restrictive immigration laws in the 1920s led to the National Origins Quota System; by 1924, the legal entry of Spanish citizens had been reduced to just 131 persons annually. The era of the itinerant sheepman was over.

During the Second World War, abundant job opportunities and military service further reduced the number of American herders, while at the same time meat and wool were crucial to the economy and war effort. In response, the Department of Immigration allowed several contingents of Basques to enter the country on a temporary basis, and Congress passed an unusual series of bills known as the Sheepherder Laws. Introduced by western senators and representatives, these laws conferred permanent residency upon Basques who had entered the United States illegally—usually by jumping ship in New York, Galveston, or San Francisco—and had then made their way to the sheep areas, where they were welcomed by the desperate ranchers. Once out on the range with the sheep, they were hidden from the authorities. Between 1942 and 1961, 383 men had their status legalized under the Sheepherder Laws.

The piecemeal approach of the Sheepherder Laws, however, failed to alleviate the growing labor crisis. In 1950 western legislators led by



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Unpopular in the West during the early part of the century, Basques were often depicted as unruly barroom brawlers on their infrequent visits to towns.

Senator McCarran of Nevada, himself an ex-sheepman, sponsored legislation to exempt the Basque sheepherders from the Spanish quota. Consequently, the initial legislation permitted 250 herders to enter the United States and the numbers were increased in subsequent years. The Western Range Association has since imported thousands of herders from Spain and presently recruits between 300 and 400 annually. These men sign three-year contracts, during which time they are required to work for sheep ranchers, but upon termination of the contract they are eligible to apply for permanent-resident status. Once this is obtained, the herder is free to work at any occupation he chooses and may remain in the United States indefinitely.

Because for more than a century Basques have been closely identified with herding, it has been assumed—for the most part, erroneously—that they have an extensive Old World background in the handling of sheep, and that they possess an exceptional psychological tolerance for solitude. This latter point merits further consideration.

Today the contract herder travels by jet from Europe to the western United States. In many cases, 48 hours after he has taken leave of his family, he is out on the range under the tutelage of an experienced herder. Once he learns the trade, he is given charge of his own dogs and sheep band.

During the lambing and shearing season of late spring and the period of shipping in the early fall, the bands of a particular outfit are concentrated and the herders enjoy each other's company for several weeks. Some may travel to a distant town to enjoy a few days of relaxation in a Basque hotel or to attend a Basque festival. Most, however, are herding for the single purpose of saving almost every cent they earn. Consequently, they may even forego the two weeks of vacation due them under their contract simply to avoid the temptations of towns. Many herders return to Europe after three years with several thousand dollars, no knowledge of

After grazing in the high summer ranges, bands are herded over the hills of northern Nevada to the low winter range.

An orphaned lamb is slung on a horse until the herder finds a ewe to accept it.

English, and almost no experience other than that gained in the sheep camps.

When trailing and when on the winter range, the herder is likely to have the daily companionship of at least one other man. Once the previous year's lambs are shipped off for butchering, two bands can be combined into one for the winter. In many outfits the two herders will spend the winter together, with one acting as the other's camp tender.

When the bands are on the high summer range, however, the herder's physical and social isolation is almost complete. Each band occupies its own large tract—enough pasturage to support a thousand ewes and their lambs for an entire summer. This means that there are likely to be several miles of rugged mountain country separating one herder from another. During a period of four or five months, the herder's only direct human contact is with the camp tender.

The camp tender, operating out of a base camp and supplied from the main camp, delivers goods on muleback to the three or four herders who are his responsibility. Frequently, the herders are a half day's journey away, which means that the camp tender requires a day to service each. Since he also spends a day preparing and baking large loaves of "sheepherders' bread," he is likely to visit each herder only about once every five days. The distances are great, so the camp tender's visit with the herder is likely to be short, usually only an hour or two. But these visits can be highly charged. The shrewd camp tender treats his herders to a good deal of horseplay, jokes of a sexual nature, and consciously animated conversation. The only other visitors are occasional backpackers who happen along. Actually most herders try to avoid them; the Basque's lack of familiarity with the English language and American culture makes such encounters awkward at best.

Such, then, is the sheepherder's solitude today. When conversing among themselves, the men express greater concern for the problems of boredom and keeping their sanity than for the physical difficulties of life on the open range. Memories of the mental anguish of the first few months are particularly vivid. Some men recount that they cried themselves to sleep at night, and that during the long hours of the day, their minds were hyperactive, running over their lives in Europe, causing both a keen nostalgia for home and a revival of long-forgotten unpleasant incidents, which were then worried over anew. At some point, however, the herder becomes inured to his circumstances and learns to tailor his mental activity to the demands of his situation.

There is always the danger, of course, that a man will manage his solitude only too well. The herders have a vocabulary of madness in which the individual who has slipped over the edge is graphically referred to as having been "sagebrushed" or "sheeped." Fear of these derangements is not unfounded. In earlier periods of western history there were frequent newspaper reports of the detention or institutionalization of a "crazy Basco sheepherder." When, in 1907, the Basques of Boise, Idaho, founded a mutual aid society, formal provisions were made to assist the mentally unbalanced to return to their families in Spain and France.

Similarly, there were frequent accounts in the early western newspapers of Basque herders committing suicide. Even now, in the Spanish Basque country, the villagers recognize that returned herders have undergone a personality change. They view them as being highly introverted and having a penchant for seeking out the company of other ex-herders. Many never resume normal social intercourse, while others require several months before they begin to converse freely.

While the personalities of most herders are affected by their experiences, in the majority of cases the change is not so extreme as to call their sanity into question. The herders do cope with boredom and solitude in a variety of ways. The question becomes: how does man, the social animal par excellence, maintain his sense of humanity, his concept of self, in a state of almost total social isolation? The Basque sheepherder takes three measures: he humanizes the natural environment, personalizes his dealings with his animal charges, and resorts to stimuli from the outside world, such as radios.

Summer herding is characterized more by boredom than by hard physical labor. While the herder must check the band occasionally to see that it remains within the confines of a particular day's grazing area, he is otherwise free to while away his time. Fishing, reading, napping, and puttering around the camp occupy many of his hours. Some men develop special interests, such as whittling or playing a musical instrument. It is said that one herder spent his free time turning over rocks, squashing the insects that he found, and then meticulously recording his kills in a notebook.

There are two particular ways in which the majority of herders use their spare moments, while at the same time placing a human mark upon the natural environment. Over the years, many of the rocky, treeless, windswept ridges of the high country have acquired the appearance of ancient cemeteries. As far as the eye can see there are piles of carefully arranged stones, called *arri mutillak,* or "stone boys." Some of these are as tall as a man, mute monuments to the boredom of hundreds of Basque sheepherders.

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Wherever there is water in the mountains, aspen groves, the favored campsites of the sheepherders, are sure to grow. Over the decades, Basques have transformed such groves into veritable galleries of tree carvings. The technique involves serrating the bark of young saplings with the blade of a penknife. As the tree matures, the scars widen, bringing out the designer's intent. Basque tree carvings on some of the largest trunks date from the end of the last century.

The themes of the carvings are many, although the majority are a simple "Kilroy was here" documentation of the carver's name and the date. The messages on some trees, however, are considerably more profound. One trunk discloses verses about the author's joy at the prospect of returning to his homeland; another comments upon the difficulties of the herder's life. Sexual ditties are common, while statements like *Viva Navarra,* "Long Live Navarre," and *Gora Euzkadi Azkatuta,* "Long Live the Free Basque Country," reflect Old World regional loyalties or commitment to the modern Basque nationalist movement. Finally there are trees adorned with drawings, some amateurish and others highly skilled, whose subject matter ranges from pornography to abstract design.

Few herders camp in an aspen grove without examining the tree carvings left by earlier herders, and they rarely move on without leaving their own mark on the youngest saplings. Thus, in the midst of his personal loneliness the herder has a sense of being in communication with both past and future generations of sheepherders.

For lack of immediate human communication, the herder often personalizes his relations with his animals (jokes about sheepherders notwithstanding, cases of sodomy are extremely rare) and develops a keen sense of companionship with them that is very different from the affection an urbanite feels for his pets. He does not talk at or to his dogs, pack animals, and sheep, but rather with them. Rarely does he give them direct orders; instead he verbalizes his thoughts as if engaged in a dialogue. Shouting across a canyon at an errant band, he asks, "Where do you think you are going? You know that you should bed down along the creek." I have witnessed herders holding lengthy conversations with their dogs in which they explained the plan for the day.

In the sheep outfit there is a necessary working relationship among men, dogs, pack animals, and sheep, the success of which depends upon the cooperation of all. It may take years for a herder to develop the proper mutual understanding with his dogs that makes man and canine a finely honed team capable of caring for the sheep with the greatest possible efficiency. To a lesser degree, the same is true of the relationship between the herder and his mount and pack animals. The herder likewise comes to recognize many of the sheep as individuals, each with its peculiar temperament and problems. Similarly, the band as a whole is seen as having its own characteristics to which the herder must adapt his herding practices. A winning combination of herder, dogs, pack animals, and band is not achieved overnight, nor should it be modified lightly. Herders have quit their employers when told they would be given different dogs or a different band of sheep.

The sheepherder's physical isolation and lack of English largely preclude his participation in the wider society of the American West. Frequently, his only link with the outside world is his camp tender who brings not only his supplies but also reading matter and his correspondence from Europe. Most of the herders are poorly educated and are not accustomed to letter writing or extensive reading. It is common for a herder to go for months without writing his family, and some older herders have stopped corresponding altogether. Most herders have three or four books: Basque-language verse is popular, as are cheap editions of Spanish-language novels. The latter rotate among the herders. A very popular publication is the *Boletín del Banco de Vizcaya,* a newspaper published expressly for Basque herders by a banking concern in the Basque country. It features information about European Basque sporting events, as well as detailed news of the villages from which the majority of herders are recruited. The herder may also acquire a few American magazines, more for their pictures than their text. Not surprisingly, *Playboy* is a likely choice.

The herder's daily link with the outside world is his transistor radio. But again, his listening habits underscore his indifference to American life. The transistors are usually powerful enough to pull in Spanish-language radio broadcasts from Los Angeles and northern Mexico. Many listen to the daily Spanish-language newscast from Washington, D.C., but the most popular programs are the Sunday afternoon Basque-language broadcasts that originate on the local stations of Boise, Idaho; Elko, Nevada; and Buffalo, Wyoming.

Basques who go to the West to herd sheep do not bring to the occupation either a specialized European background in sheepherding or a unique psychological capacity for social isolation. Rather, despite the romanticism surrounding them, they show a pronounced determination to undergo temporary physical and mental privation as an investment in a secure economic future. It is not that Basques suffer less than others in the solitude of mountains and desert; it is simply that they are more willing to endure the privations. ■

Before they are driven to the high summer ranges, sheep are corralled in the spring for shearing.

BILL BELKNAP-RAPHO GUILLUMETTE

Flowers of the Sea

Waving from coral reefs, these colorful creatures toil not, neither do they spin, but . . . they eat quite efficiently

by Meredith L. Jones

When we prisoners of the air turn to things aquatic, we quickly find that experience has poorly prepared us for the diversity of shapes and colors found in the marine world. We can recognize food items—fish, crabs, shrimp, and clams—and can take comfort in the similarity between aquatic and terrestrial snails and between pill bugs and marine isopods. But we would probably overlook the vast majority of organisms present in a marine habitat. For one thing, most of the animals living there are of microscopic size. Further, most of these, as well as other, larger forms, live in the substratum or in its overlying flocculent layer, and without a shovel or sieve, they, too, would escape our notice. The third reason for our ignorance lies in the strange shapes and forms assumed by both familiar and unfamiliar animals.

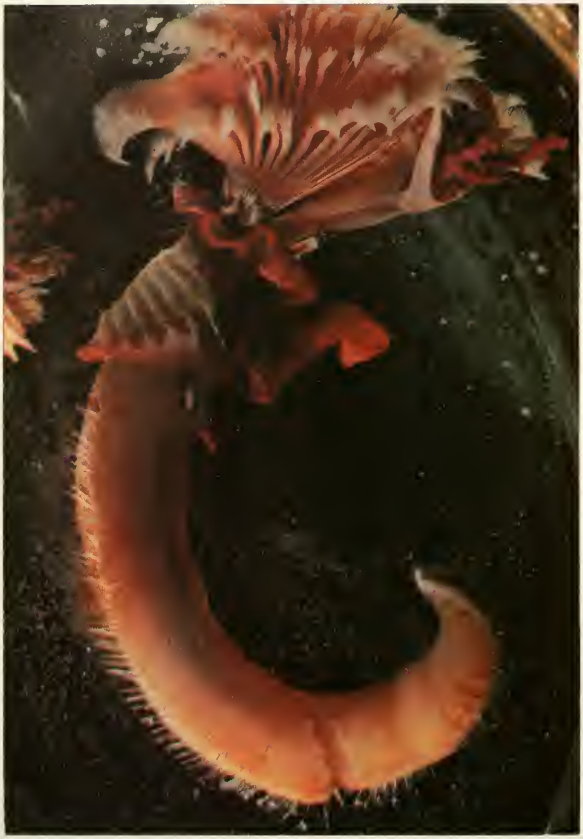
In the case of sea anemones and certain marine worms, one might easily be convinced that they were flowering underwater plants. The sabellid and serpulid polychaete worms look so much like terrestrial blossoms that I often have to tell people these forms are *not* the flowers of the coral reef.

Actually, these showy portions, the so-called branchial crowns of the feather duster worms, are featherlike structures whose bases are in paired semicircles or spirals about central axes. The members of these two polychaete families are similar; however, the sabellids live in a flexible tube made up of rather fine particles cemented together by mucous secretions, while the rigid tube of the serpulids is built up of calcium carbonate secreted by the worm. In addition, in serpulids one of the "feathers" of the branchial crown forms an operculum, which closes off the opening when the worm draws into the calcareous tube. The serpulids often have a frilly membrane on their dorsal surfaces, just in back of the branchial crown. This structure, the thoracic membrane, and a collarlike organ lay down the carbonate building material of the tube.

One function of the branchial crown, as its name implies, is respiration, although it is not solely responsible for this process. Not infrequently, branchial crowns are nipped off by fish predators, and this may cause a 60 percent decrease in the animal's oxygen consumption. The remaining respiration is presumably carried on over the worm's body surface.

Between the red sponge and coral in the foreground and a branching gorgonid, rear, a cluster of sabellids emerge from their protective tubes.

photographs by Carl Roessler



A female serpulid, above, spawns orange eggs after it has been extracted from its tube. The larvae settle on hard surfaces, such as coral, right. As the young sea worms grow, the length of their tubes increases.

A clump of sabellids undulate gently on a coral reef. The motion of the feathery branchial crown is part of the sea worm's feeding process. Suspended particles in the water pass through a fine network of traps, which discard the larger items and route smaller pieces toward the worm's mouth.

All of the feather duster worms have developed several adaptations to protect themselves against loss of their branchial crowns. They withdraw rapidly when they detect shadows or vibrations, and many crowns have photoreceptors in the form of eyespots or compound eyes. In addition, their ventral nerve cord, which serves to coordinate all body movements, is augmented by large single-nerve fibers that can transmit impulses with extreme speed, thus insuring the immediate and simultaneous total response of the worm. The speed of the withdrawal response is best illustrated when you attempt—and almost certainly fail—to catch the branchial crown with your fingers.

The primary function of the branchial crown is feeding. Each part of the crown is somewhat like a feather; it has a central rib, the so-called radiole, which bears a series of laterals, or pinnules, on either side. The upper surfaces of both a radiole and its pinnules have mucus-secreting cells and grooved, ciliated tracts. The cilia beat downward and inward toward the mouth, which is located at the base of the radioles. Other beating cilia on the pinnules set up a current of water, which, along with suspended material, passes from the outside to the inside of the crown. When the worms are feeding, the pinnules of adjacent radioles are intermeshed, and this network traps suspended material on the mucus of the ciliated tracts.

In sabellids, this material moves toward the mouth by way of a sorting mechanism, which is composed of a deepened trough with a series of folds. Effectively, there are three ciliated tracts. One, at the upper margins of the trough, prevents large particles from settling down into the lower levels. The second, formed by mid-depth folds, collects particles of intermediate size. At the bottom, a narrow tract accepts only the finest particles.

Each category of particles has a different fate. The largest ones are shifted to the edge of the branchial crown and discarded along with fecal material. Intermediate particles are moved to a pair of ventral sacs, where they are stored, mixed with more mucus, and used to build the tube. The ciliated tracts carry the finest material to the mouth of the worm for food. The feeding of the serpulids is similar, differing only in the lack of an intermediate sorting mechanism since their tubes are made of secreted calcium carbonate.

Thus, the esthetically appealing "flowers" are wonders of efficiency, deceptively straightforward mechanisms for carrying out the crucial job of feeding these sessile worms that inhabit and decorate coral reefs.

Letters from Golden Sardis

Excavations at the crossroads of Asia Minor, where Croesus minted his fortune, have brought fourteen years of complications, disappointments, and triumphs to a persistent archeological expedition

by George M.A. Hanfmann

We were certainly not going to object to treasures, but treasures were not our aim when we began the Harvard–Cornell–American Schools of Oriental Research expedition to Sardis. "The prime objective of any research at Sardis is the Lydian city of Croesus and his predecessors . . . which remains completely unknown." This was the statement we made in our proposal of 1958. Beyond that we envisaged the study of the development of all human settlements in the Sardis area, from the Stone Age through the earlier Islamic phases. "Here astride the major road into Asia, Mediterranean and Eastern peoples, cultures, and religions met and interacted. . . . Thus Sardis is uniquely suited to demonstrate the modern multidisciplinary approach in which humanists and scientists open new vistas upon the history of humanity." We hoped to reconstitute a case history of urbanism in a vital region between East and West.

According to literary sources, the city of Croesus held such major targets as the temples, the agora described by Herodotus, the mint, where the earliest coins in the world were made, and, above all, the palace of Croesus whose archives must have contained correspondence with Assyria, Egypt, Babylon, Media, and most of the Greek states and sanctuaries.

We could hope, too, to resolve some major controversies which had resulted from the decipherment of the Royal archives of the Hittite kings at Hattusa (Boğazköy). Some scholars thought that Hittites had penetrated Lydia. Others saw in it the kingdom of Assuwa which, in turn, gave the name of Asia to the entire continent. Others thought that the region might have belonged to another Indo-European group, the Luvian. Others pointed to Herodotus' statement that the dynasty of the sons of Herakles had assumed rule over Lydia and Sardis 505 years before the accession of the Mermnad Dynasty and king Gyges (680 plus 505 would make it 1185 B.C.), and suggested that Mycenaean Greek heroes wandering about after the fall of Troy might have seized the region; and yet others thought the forerunners of the Etruscans might have lived at Sardis when it was still called Hyde.

Excerpted from *Letters from Sardis*, published by Harvard University Press. © 1972 by the President and Fellows of Harvard College.

The Bollingen Foundation had stipulated that its grant should be matched by Harvard and Cornell jointly. Under the Harvardian system of ETOB ("each tub on its own bottom"), I had to find the means; and thus came into being the Supporters of Sardis, an informal group whose contributions came to carry the show through its ups and downs. . . . To communicate with these friends, I started writing letters from the field, usually three each season; and another letter went to the members of the American Schools of Oriental Research.

In Classical antiquity "Golden Sardis" was a name to conjure with. "I do not care for the gold of king Gyges," cried the Greek adventurer and poet Archilochus defiantly; but the rest of the ancient world did. The kings of Lydia of the Mermnad Dynasty from Gyges to fabulous Croesus (*ca.* 680–547 B.C.) made Sardis the Paris of the ancient world. . . . For a century and a half, the kings of Lydia ruled a kingdom extending from the Aegean to Iran. By a skillful combination of religious and financial propaganda, they enlarged their influence in the Greek world. They ruled this empire from their well-nigh impregnable citadel at Sardis, some 65 miles inland from the coast

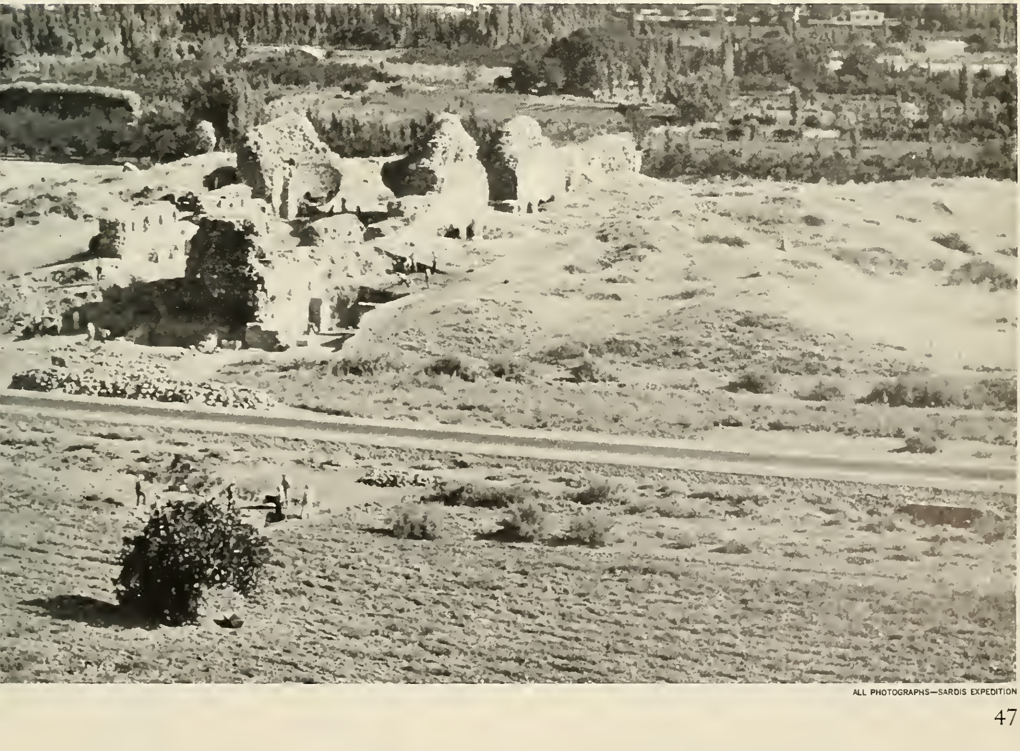
of Turkey, in the rich Hermus plain (Gediz Çay), under the foot of the towering Tmolus mountain.

"The land Lud I took, their king I killed"—such was the terse account given by Cyrus, the conquering king of Persia, after he overthrew Croesus and captured the citadel in 547 B.C. As *Sfarda*, Sardis became the seat of the most important Western satrapy, the western terminal of the famous Royal Road along which mail couriers sped from the distant capitals of Susa and Persepolis toward the Mediterranean. The King of Kings trod on purple rugs woven at Sardis, and piled up gold from Sardis in his treasury.

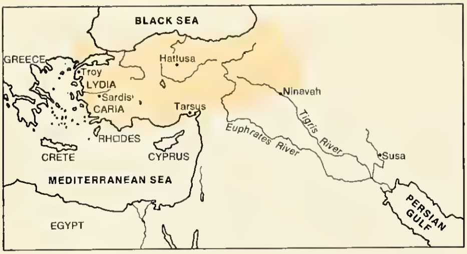
In 499 B.C. the Ionians marched across the Tmolus and burned Sardis, starting the great wars between Persia and the Greeks. Herodotus, who knew Lydia well, writes, "Though they took the city, they did not succeed in plundering it. . . . The Lydians, and such Persians as were in the city, came in crowds into the marketplace, and gathered themselves upon the banks of the Pactolus. This stream, which comes down from Mount Tmolus, and brings the Sardians a quantity of gold dust, runs directly through the marketplace of Sardis, and joins the Hermus. So the Lydians and Persians, brought together in this way . . . were forced to stand on their defense; and the Ionians, when they saw the enemy in part resisting, in part pouring towards them in dense crowds, took fright, and . . . went back to their ships." In revenge, the Persians mustered their huge armies against Greece in the Sardian plain, and Aeschylus writes of Lydian charioteers from golden Sardis as Persian allies.

In 334 came Alexander the Great who captured the great citadel without a fight. As key fortress and capital, Sardis became a bone of contention among the successors of Alexander; kings from Macedon, Syria, and Pergamon contended for the city. The Seleucid dynasty of Syria transformed the Lydian capital into a

In 1960 only grass-covered stone walls could be seen at the site of the Synagogue and the Roman Gymnasium.



ALL PHOTOGRAPHS—SARDIS EXPEDITION



typical Greek city (*ca.* 270–190 B.C.), and it is they who built the huge Temple of Artemis. Later in this period came another dramatic change in the history of Sardis. Prince Achaeus, discovered to be conspiring against Antiochus III, was besieged for two years (215–213 B.C.) on the citadel, and was finally captured and killed. Antiochus first severely punished the city and then refounded it on a Hellenistic urban plan. Under the kings of Pergamon (180–133 B.C.), then under the Romans (beginning 133 B.C.), Sardis was still a major government and industrial center, famous for gold-woven textiles.

A fierce earthquake struck the region in A.D. 17, but the city came back with the help of the emperors Tiberius and Claudius. . . . As metropolis of Asia, seat of many wealthy and influential families, it led a peaceful and prosperous existence under the emperors Trajan and Hadrian, and the Antonines and Severans.

Meantime another kind of fame was to attach itself to Sardis. In Obadiah mention is made of exiles from Jerusalem "in Sepharad"; thus there were perhaps Hebrews in Sardis under the Persian rule in the fifth century B.C. After the uprising of the Lydians who sided with Achaeus in 215–213 B.C., Antiochus III brought 2,000 Jewish veterans with their families from Mesopotamia to Lydia. . . . It is in the ambient of such Jewish congregations that Christian groups began to organize. By the time of Nero, St. John of the Revelation addressed the church of Sardis as one of the seven earliest Christian communities of Asia Minor. . . .

The dangerous decline of the Roman Empire, and especially an attack by the Goths in 253, shook Asia Minor, and we hear of bad conditions in the Lydian countryside. Under Constantine (306–337) security was restored and there was considerable building activity in the fourth century. . . . From inscriptions it seems that Sardis, a metropolitan see, was still flourishing in the sixth century.

The Arab invasion in the early eighth century reached Sardis; and later historians made brief mention of battles between Byzantines near the city; then the Turks appear. . . . But the city declined rapidly. In 1369, the Patriarch of Constantinople wrote that Sardis "formerly reckoned among the greatest and first . . . now does not even preserve the appearance of a city. . . ." Thereafter only small Turkish villages remained around Sart, as the place was now called.

Istanbul April 12, 1958

You may want to hear about Sardis first. I found it as impressive as ever in scenery and antiquity. I had never seen it this early in the year, and in some ways it looks grander, more awe-inspiring, at this time when spring contends with winter. Snow still lay on the highest tops of the Tmolus range and vaporous, torn clouds floated along its wooded flanks. Wetness—and wet it was two out of three days—brings out different aspects of the ruins, in fact even different and new ruins.

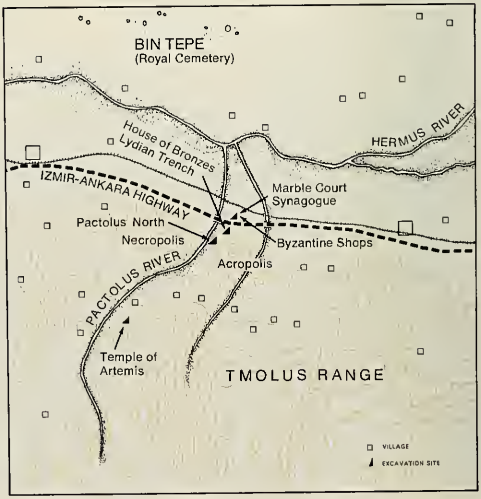
Sardis August 1, 1958

At the beginning of July we had to pause briefly to celebrate the Kurban Bayrami commemorating the sacrifice of Isaac. All through the moonlit night the drums were beating at the upper and lower village, and some of our younger members were induced by their local friends to join in the men's dancing at the small kahvehane.

We have begun to develop our program of combining investigation of large buildings visible above ground with soundings designed to test promising areas. The large structure known as Building B . . . has never been excavated or recorded. With its two long apsidal halls, its intricate system of pillars, niches, and arches, and its central unit which may have had a dome, this complex presents a great challenge to the student of architectural history.

Sardis August 12, 1958

We decided on a trial trench right by the highway, across from Building B and the Byzantine Shops which we have been excavating for the past few weeks. We thought we might find in the new sounding the main street of Sardis, which must have come through the hollow.



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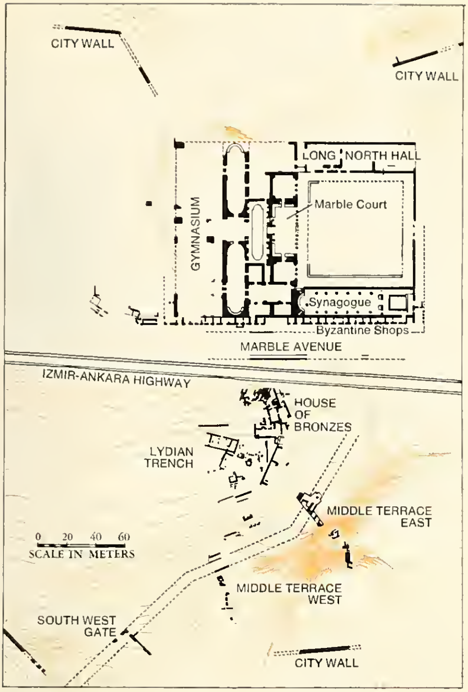


Hardly had Don Hansen's crew set to work . . . than ancient walls began to appear practically under the melons. It was really amazing that anything could grow five to ten inches over an ancient structure. Interesting finds were made from the start, but the walls looked like a labyrinth. And then, as Don patiently cleaned and cleared this welter, there appeared lying in the earth the wholly visible shape of an ancient bronze vase. This happened during the last hour of work, too late for the delicate operation of extraction. We appointed a laborer to guard the treasure during the night. . . . The next morning found all of us hopping up and down, for not one but three bronze vessels were coming out, one of them a large bronze basin, or brazier.

One room in the first story of this "House of Bronzes" had a floor paved with the biggest tiles we have seen; traces of painted walls—unfortunately only in small shattered fragments—are visible. An elaborately patterned marble floor has been revealed in another room at the basement level.

Cambridge September 17, 1958

I had meant to write this letter at Sardis, but our last days "on location" proved to be extremely hectic. The big schoolroom and the schoolyard were a chaos of boxes, wheelbarrows, pickaxes, and more boxes. We were working feverishly to pack part of our finds for shipment to the museum at Manisa, another lot was to be stored in the village, and all of the excavation equipment was to be "winterized" and stowed away. . . . Every couple of hours or so, a taxi with journalists would drive up and we would be cajoled into posing with our trophies. . . . Our first move was always to explain that we had *not* found the treasure of Croesus, and, indeed, believed that Cyrus had taken it long ago. Now the belief that the treasure of Croesus still lies hidden at Sardis is almost an article of faith with many people in Turkey; and when the Associated Press carried a dispatch that we had found the site of the city of Croesus, there was a rush to see what we had done with the treasure. Indeed, the first intimation we had was the appearance at midnight of two armed state troopers, who stated that they had been dispatched by higher authorities to guard the treasure, and asked why our commissioner had not reported the find and its contents. Our genial Kemal Bey replied with great good humor that if the gentlemen would show him the treasure, he would be the first to report its contents in detail.

Next day, shortly before work was to stop, I was passing by the House of Bronzes. Beaming, our commissioner shouted, "Mr. Professor, une belle surprise!" and ran off toward the solitary tree which served to provide shade for drinking water and pot washing. Out of the earth of the small trench peered several majestic necks of vases, still upright; and Don came back with unmistakable early Lydian sherds that had just been washed. Here were the Lydians.

We were still cautious and batted the facts back and forth. "Looks good, but could they have been thrown in with the fill?" "I think we are coming on a floor"—and so we were. Although my instinct was to jump up and down for joy, we held back. But two days later there could be no doubt. In the small space of not more than 15 by 9 feet were a dozen large vase necks and upper bodies, pot stands, the characteristic "lydia." So tightly packed an array of pottery could not have been placed by chance, and our workmen had the same idea as ourselves—a pottery shop.

The search for the site of the Lydian city, then, seems to have ended; but the *excavation* of the Lydian city is only about to begin. This will be a long and important task for our future campaign.

Sardis August 1, 1959

We are just past the midway point of this, our second campaign of digging at the ancient capital of Lydia, and work is going forward on five sectors of the far-flung site. As the tempo rises, discoveries crowd each other. Yesterday and today brought us the first life-size, indeed larger than life-size, marble statues. A Roman official and his wife were lying foot to foot right under the entrance to the shelter used as sector headquarters . . . only a foot or so underground.

Cambridge September 1960

Just before I left for my flying trip to Germany late in July, I was presented at tea with a box mysteriously wrapped and tied with the cord of Tom Canfield's bathrobe. The contents made me whoop with joy, for here were fragments of a most exquisite Attic black-figure drinking cup, with inscriptions. Don had found it on the Acropolis in a "pocket" of early material just above native rock. When put together, the fragments yielded a drinking cup made in Athens at the time when Croesus ruled over Lydia (561–547 B.C.). . . . It was probably broken at the time the Persians stormed the citadel and captured King Croesus.

The House of Bronzes area kept us on tenterhooks to the very end of the campaign. Proceeding with tenacity and determination, Gus Swift first uncovered a sizable stretch of Lydian levels, and then descended into the bowels of the earth to pursue the quest of pre-Lydian Sardis. . . . We interpret these [Lydian structures] as part of a shopping area comparable to the open-air markets of modern Turkish towns. . . . Digging through a deep flood deposit, Gus came upon one earth floor after another. Archeologists will have plenty to discuss and debate, but we believe we have a continuous sequence of settlements spanning the darkest period in the history of Asia Minor, from the Late Bronze Age of the thirteenth century B.C. to about 700 B.C., the beginning of the historical dynasty of the Mermnads. This, to my knowledge, is unique for Western Asia Minor. A great burned level occurs in the early twelfth century B.C.. the time when, according to Herodotus, "the sons of Herakles" established their rule over Lydia—the time, too, when the Hittite Kingdom perished in the violent migrations that threw all the Aegean and much of the Near East into turmoil. . . .

Sardis July 25, 1961

I was waiting for something special to happen—and it did. I had come across the sun-parched foothills of the citadel from the Pactolus Cliff, where we are uncovering a beautiful colored mosaic . . . and finally arrived at the House of Bronzes where our young architects, Charlie Rogers and Stu Carter, were crouched over our pottery dump studying vases. I picked them up and we went to get some levels for our spectacular "Road Trench." Here Dave Mitten has uncovered, in rapid succession, the late medieval, the Middle (?) Byzantine, and finally the imposing Roman road, which is paved with huge stones and flanked by a majestic colonnade with mosaics. This was the "Fifth Avenue" of Sardis, and the successor to the famed Royal Road of the Persian kings.

Charlie and Stu went to work, and . . . a shout went up from the workmen—and there was my something special. A beautiful marble head, lying face down in the debris over the Roman road. The head of a bearded man with wavy locks, breathing an almost fanatic, expressive spirit—which has led some scholars to describe this kind of "Proto-Byzantine" sculpture as "soul portraits"—and yet retaining in the modeling something of the refined vitality of Hellenistic sculpture.

Cambridge September 1961

As we left it, [the] Pactolus North sector has rooms with mosaics at the south end; a contemporary Late Roman bath in the middle; and in between and to the north, first the richest collection of water pipes going, presumably from a Roman reservoir that distributed water into the city: then Persian apsidal structures, one with a wonderful circular well nearly thirty feet deep, which began to function again the minute it was excavated; finally, Lydian rooms, again with a well. The Late Roman or Early Byzantine bath is a most elegant affair and eloquent testimony for the prosperity of Sardis at a time when the Western Roman Empire was disintegrating. Again and again, Sardis shows how continuous was the development from the Roman to the Byzantine era in Asia Minor, and our excavation may well become one of the most important sites for this transition.

These headless statues of a Roman official and his wife were found lying foot to foot near the House of Bronzes.

Sardis July 1962

In the Pactolus North sector, Mario Del Chiaro is clearing an area of nearly 1,000 square meters. It is bounded on the east by a very interesting Byzantine church. What appears to be a street is flanked by a long building on the south and an array of units with mosaic floors on the north. The mosaics are the most ambitious we have yet found. One has a circular motif in the center, encircled in turn by four blue dolphins, and features, in other panels, dogs hunting a stag and a hare. Another room has an eagle and various animals, all in five colors.

Sardis August 9, 1962

We believe we have found the Synagogue of Sardis. Dave Mitten had started a trench northward from Jacob's Shop, mentioned in the last letter. We had fully expected to find a colonnade which should go around all four sides of the gymnasium court. Instead there appeared a wall luxuriously revetted with marble and fragments of a long inscription. . . . A large mosaic floor spreads northward for many meters—much too wide for a colonnade. I happened to be on duty when the evidence was found—a relief with a seven-branched candlestick and tree and an inscription in Hebrew letters.

Sardis August 6, 1963

We all knew that last year's discovery of the Synagogue was an event of importance but none of us had quite expected the spectacular size of the structure and the splendor of its furnishings or the surprising finds that have been pouring from this building.

The over-all dimensions are imposing—length 270 feet, width 60 feet: the wall of the apse is preserved up to a height of 15 feet.

Sardis August 9, 1963

A unique monument of archaic art celebrating the great goddess of Lydia, Cybele, has just been discovered. To the surprise of the excavators this jewel of archaic sculpture was found among the ruins of the Synagogue of Sardis.

The marble monument, originally about four feet high, shows the great goddess Cybele in the dainty attire of an archaic Greek maiden. She stands in her shrine holding a little lion (much effaced) before her breasts. Two mighty snakes rise full height on both sides. The style of the frontal figure is that of the finest marble sculptors of Ionia. Ionic columns rise along the sides and at the back, showing that the building is a shrine.

Istanbul October 1, 1963

In the sector Pactolus North, Henry Detweiler led a team of architects in the excavation and architectural recording of the fascinating Byzantine Church E. One surprise was the appearance of a rectangular space with steps and geometric wall paintings below the floor of the church; tentatively, it is interpreted as a baptistry. Henry has discovered another matter of import for the history of structural engineering: a curious grid of wooden beams under the church floor which apparently was intended as an anti-earthquake device.

Sardis July 30, 1964

For six seasons we had labored to excavate this grandiose complex [the Marble Court]. Steve Jacobs had worked valiantly at the task of evacuating and recording the sea of marbles. This year about 1,100 stones were staring us in the face from the field and the slopes east of the Gymnasium area, as a result of his effort. Jim Yarnell arrived on July 1 and quickly got his bearings; now a majestic scaffolding is rising some forty feet in the air.

The scaffolding is to serve the restoration of the most striking feature of the entire Marble Court complex—the monumental gate at the back of the court with its four spiraling columns. But what effort and expense it takes to accomplish such a task! Take, for instance, just the question of replacing one of the monumental bases which is missing. We were jubilant when we discovered that the ancient marble quarry of Sardis used for the building of the Temple of Artemis was being reopened. A long uphill walk to this romantic gorge where a crew is working elicited the information that neither the transportation from quarry to us nor the quality of marble should be counted on. Our foreman went off to Izmir to look at some marble blocks there—and they turned out to be too small. . . .

Cambridge September 25, 1964

An exciting finish was put on by Noel Robertson on the Pactolus. Here under great flood deposits there emerged Lydian houses better preserved than anything we have seen so far. The area seems to have been densely inhabited, and perhaps not built over. We may be approaching there the agora of the Lydian and Persian city. . . . A strange monumental complex with curving walls seems to be the work of the Persians. In addition to fine Attic black-figure sherds, a charming tiny lion in rock crystal and lumps of rock crystal hint at activity of skilled artisans nearby.

Sardis July 10, 1965

They were drilling and drilling, doweling, watching the marble cleave and splinter, putting in reinforcing rods, building up slowly, bit by bit, the mighty shattered columns that originally bore the pediment of the gate into the Marble Court. This went on all of last season and the first weeks of this. A three-ton fragment hangs suspended from the beam of the scaffold—and still a crucial part is missing. And then, yesterday, three huge shafts of these gorgeously textured columns appeared in the excavation which Jack Kroll and Andrew Ramage are conducting behind the Marble Court. . . . There is tension and bustle about construction, as sidewalk superintendents well know; but even greater tension about reconstruction, where so many things are unknown. Yesterday's find was the great moment of triumph of this campaign so far.

The discovery of this menorah relief positively identified an excavated ruin as the Synagogue of Sardis.

Sardis August 10, 1965

The problems of the Synagogue are challenging. We do not yet safely know whether the earliest structure, clearly an integral part of the Roman master plan for urban renewal of Sardis after the horrible earthquake of A.D. 17, was a synagogue. We are encountering very complicated arrangements for foundations and have yet to determine whether they were built for one or two buildings. We do know from inscriptions that the Synagogue was built between A.D. 175 and 200 and rebuilt between 350 and 400. We are now seeking to determine what has survived from the original plan and construction. To give one example: the imposing apse of the Synagogue is built into a Roman nymphaeum . . . which in turn is built against a main wall of the Roman Gymnasium.

August 1 was a day of triumph for the Marble Court team. Three times did the eight-ton column shaft rise into the air, as the Austrian giant tripod and our small winch were used to maneuver the piece horizontally and vertically. Each time there was still some fault in the setting. Finally Mehmet Ergene, who directed the operation, set the thirteen-footer down on its base, perfectly plumb and level. He had to lift it again in the afternoon to "grout" the surfaces and make final adjustments—and nearly lost his hands and possibly worse when the column came down seconds after he had inserted a leveling piece of lead. Although the column part set is less than half of the total height, already this majestic, spiraling giant evokes the vision of the splendid, monumental gate.

Sardis September 1966

I had started this letter on August 12, the day when the House of Bronzes deep pit had produced what for many archeologists and historians will be the most exciting find of the season. For years scholars have looked for a place in western Anatolia where the transition from Bronze to Iron Age might be clearly seen, and where evidence might relate this change to the great upheaval in Greece which brought with it the downfall of the Mycenaean kingdoms. Gus Swift and Andy Ramage came upon stone walls, storage jars, and the like; but with them, broken but reasonably complete, was a very early Protogeometric Greek painted vase. The next deeper level came up with fragments of a crater, so-called sub-Mycenaean, or very late Mycenaean, again imported from Greece. The skeleton of a donkey lay next to them.

Sardis June 30, 1968

Gus Swift's main purpose is to secure more data on the plan and precinct wall of the seventh century B.C. Lydian bazaar, very important for the history of urbanism. A strange and macabre discovery has added unexpected information. Gus was looking at the deep pit he dug in 1966 when like Hamlet he found a skull at his feet. More bones were sticking out of the gravel in the side of the trench laid bare by cascading winter torrents. Careful digging and brushing have revealed several individuals, victims, we believe, of that terrible onslaught and fire when the city was stormed by Cimmerian nomads in the seventh century B.C. Two are complete; of other individuals there are only parts. One man was lying face down, the others in strange twisted positions. Were they innocent bystanders, or were the well-preserved skeletons those of Lydian warriors, or even of the enemy killed in or after the battle?

Sardis August 6, 1968

To stand where the wealth of Croesus was made; to watch his craftsmen squat at little fires, pumping at the bellows, purifying the gold in cupels, pouring it out of crucibles—this could happen only in a dream. Yet this is the scene we have discovered and can prove by tiny but telling clues.

It all began on July 6, when archeological detective Ramage, tenderly brushing a clay floor, perceived the outlines of little greenish rings. They proved to be depressions lined with clay and ashes. Some heavy, gray matter adhered to the inside of one of them. The gray matter proved to be lead slag with traces of silver. The depressions were cupels, fire-resistant containers for purification of gold or silver. Cupellation involves extracting impurities out of silver or gold by heating them with lead.

For a week or so, we had the theory, the cupels, the lead, and the traces of silver, but no gold. Then keen-eyed assistant Halis Aydintaşbaş spotted a tiny speck of gold. As the technique of sifting and searching the clay floors and industrial refuse became more proficient, more and bigger specks of gold appeared.

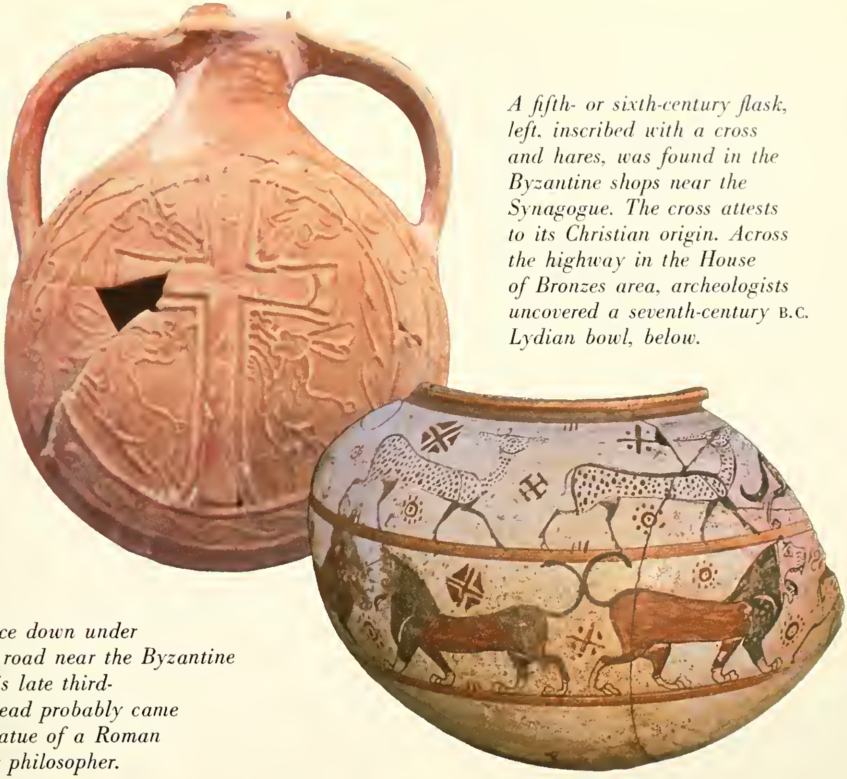
Sardis September 7, 1968

To lift the mosaics, Larry Majewski is using a new technique in which the mosaic is rolled off like a carpet. It could be put back the same way, except that we keep "looking under the rug" and finding things. Andy Seager has been waging a battle to unravel the "prehistory" of the building—the story of the structure before it became a synagogue. . . . The critical question is whether the earlier building was really a civil Roman basilica, which was turned over to the Jewish congregation in A.D. 166 under the emperor Lucius Verus, or whether there was an earlier synagogue somewhere after all, or whether this was originally meant to be a dressing room for the Gymnasium—which is what its counterpart, the Long North Hall, seems to have been.

In the Byzantine Shops along the south wall of the Synagogue, where the lion-shaped bronze lamp was found last year, Steven found a majestic pilgrim flask decorated with a large cross and small crosses, and two hares eating flowers. It seems that Jewish and Christian shops were interspersed in this shopping center.

Sardis July 18, 1971

Some stones were lying by the *depo* (storage shed). "What have they dragged in now?" I wondered to



A fifth- or sixth-century flask, left, inscribed with a cross and hares, was found in the Byzantine shops near the Synagogue. The cross attests to its Christian origin. Across the highway in the House of Bronzes area, archeologists uncovered a seventh-century B.C. *Lydian bowl, below.*

Found face down under the main road near the Byzantine shops, this late third-century head probably came from a statue of a Roman official or philosopher.

myself. Thirty seconds later, I knew. What we had not been able to find in thirteen campaigns had been delivered to our doorstep: one of the longest Lydian inscriptions known, nineteen lines of it! We encouraged with suitable reward the youthful finders who had discovered it in the spring, supposedly a couple of hundred yards upstream from us in the Pactolus bed. It may be well to explain that we pay rewards for objects found in the Sardis region which then become property of the Manisa Museum.

Epilogue

The letters end with 1971 but not the work. Still, after fourteen campaigns one may well look back and see what has been done. When we wrote our glowing forecasts in 1958, we were overoptimistic about the speed of excavating. Paper is patient; it takes ten minutes to write a paragraph promising excavation of a building; it might take ten weeks or ten months of work or even ten years and tens of thousands of dollars to do the job.

Then, in some ways, Sardis turned out to be a complicated site. Earthquakes and erosion have upheaved the slopes, and floods have deposited heavy overburden in the plain. One might almost say that what looked good turned up bad, and what looked bad turned up good. The Upper Terrace was covered on the surface with Lydian sherds but turned out to be a colossal Roman dump (1959). The melon patch along the highway looked like nothing at all; yet it hid not only the rich House of Bronzes but also one of our prime objectives, the Lydian Market. Everybody was raring to dig on the Acropolis in 1958. Three archeologists brave and true ate their hearts out and each wrote at the end of his season that the Acropolis was so much damaged by nature and upended by the Byzantines that it hardly warranted continued digging. Yet in 1971, the northern slope of the citadel suddenly revealed another palatial Lydian wall. What looked like an uninteresting patch of burned Hellenistic debris at Pactolus North led Andrew Ramage to the Lydian lion altar and eventually to the gold refinery of the Lydian kings. We have learned much about the western part of Sardis but we never did get to excavate in the central and eastern part of the site. That brings us to the third and most important limitation. As in war, so in archeology: you have to decide where and how you are going to commit your forces. . . . For the early periods, we committed ourselves to massive penetration down into the Lydian and Prehistoric strata in the House of Bronzes-"Lydian Trench" area and to extensive digging of Lydian and Persian levels in the Pactolus Cliff and Pactolus North sectors. In tackling the vast Gymnasium and the big bath complex, we were trying to do justice to the later cultures, to the Hellenistic, Roman, and Early Byzantine Sardis, and to the big architecture which was so representative of these phases.

What have we accomplished? There is, I think, no doubt that the discovery of the gold refinery on the Pactolus is as fundamental a contribution to economic and technological history of the Lydian kingdom, and, indeed, of the ancient world, as we had any right to expect. We are, literally, standing on the ground where Croesus' wealth was made.

Out of an unexpected treasure trove, the walls and piers of the Synagogue, has come a series of sculpture and architectural pieces from the time of Croesus and the Persian era which throws entirely new light on the mythology, history, and religion of the Lydians and on the origins of the Ionic order of Greek architecture.

Going back in time, our finding of Mycenaean, sub-Mycenaean, and Protogeometric levels disproved the ancient tradition that Sardis was founded after the Trojan wars, and confirmed the Herodotean story about Heraklid invaders and that of Nicolaus of Damascus about the seer Mopsos—presumably errant Bronze Age Greeks who were fighting natives and Hittite dependencies in the twelfth and eleventh centuries.

For the Hellenistic period, we have learned that the Lydian culture continued in its material manifestations way past Alexander the Great. We have learned from inscriptions built into the Synagogue piers that it was Antiochus III who in 213 B.C. totally destroyed the western part of the city in punishment for its rebellion and then ordered his powerful viceroy Zeuxis to supervise a *synoikismos*, a new founding of Sardis, apparently farther east. We have found the debris of the destruction at the House of Bronzes and Pactolus North. The repopulating of Sardis at least in part with Jewish families from Mesopotamia is the ultimate cause for the least-expected discovery of the

By 1971 the forecourt of the Synagogue, and the Marble Court at rear, had been partially restored with original pieces and cement.

Expedition—that of the giant Jewish synagogue of Roman times, far and away the largest known from the Diaspora.

Whatever its exact date, a synagogue which is an integral part of a Roman gymnasium is an amazing find.

It is this discovery . . . which is of importance for the history of the Church of Sardis. For it is to such communities as Sardis that Paul and Barnabas traveled, and also St. John of the Revelation; and it is against such background of prosperous and powerful "Hellenized" Judaism that the development of the earliest Christian communities took place.

Finally, for the Islamic era, we have proved by a hoard of Turkish "feudal" coins that the citadel was still being used around 1420 after the alleged destruction by Tamerlane (1402), and we have been able to show that making of glass objects went on at the village workshops which had been installed in the little Church E until the domes of the building were overthrown by an earthquake perhaps as late as the eighteenth century.

The full impact of our finds . . . will become evident as publication progresses; but already a dozen or so diversified publications each year attest to the interest of the Sardis finds. Architecture, archeology, anthropology, epigraphy; geophysics, geology, and metals analysis; study of languages and religions; history of all kinds—these are but a few of the general fields involved. To bring all of these together in the final synthesis on Sardis will be a high aim to strive for.

Cemetery Ecology

In search of more recreational lebensraum, urban man is beginning to exploit a new niche

by Jack Ward Thomas and Ronald A. Dixon

Being country boys, it was not unusual for us to try to escape our stuffy office in Amherst, Massachusetts, in search of a more refreshing site to eat lunch. What was unusual is that our search ended in a cemetery adjacent to the U.S. Forest Service building where we worked.

Other people, however, also had the same idea. On any clear, warm day, secretaries, bank tellers, and sales clerks could be seen having lunch and quietly conversing. Children walked or rode bicycles through the cemetery on their way to school, teachers brought their classes to the area, and tourists regularly visited the gravesite of Emily Dickinson. Wildlife, too, used the cemetery, and we often saw or heard a dozen different animal species in half an hour.

It was during these lunch breaks that we realized that urban cemeteries provide city dwellers with ideal multiple-use open space, and that these areas could be systematically managed for recreation and wildlife. Proceeding with some preliminary research in Springfield, Massachusetts, we found that cemeteries made up approximately 33 percent of the remaining open space in the developed portion of that city. But Springfield residents generally have ready access to nearby undeveloped land, and there is a supply of forested land even within the city limits. We wanted to test our ideas about cemetery management in a city that was past this stage of development, a city that had placed most or all of its land resource into specific use categories. Therefore, we chose Greater Boston.

Cemeteries in Boston and its suburbs—Arlington, Belmont, Brookline, Cambridge, Dedham, Newton, Somerville, Waltham, and Watertown—take up some 35 percent of the 4,903 acres of open space remaining in the area. Because of the scarcity of such land, the 1,716 acres enclosed in fifty cemeteries represent an extremely valuable resource. Once we had our study area, we could begin investigating such questions as: What wildlife species—especially birds—and how many, nest, feed, and find shelter in cemeteries? Can cemeteries serve as natural science laboratories for neighborhood schoolchildren? How much and what kind of recreational use is being made of these areas? What are the attitudes of cemetery managers on present and future recreational uses of cemeteries?

We found that there were twenty-three managers in charge of the fifty cemeteries in our study area, and we received ready and enthusiastic permission to study all but one. The manager of a small historic cemetery adjacent to a county prison explained that we might upset the routine activities of the prisoners, who maintained the grounds and also used them for outdoor recreation.

From June to September of last year, we traversed more than 200 miles of transect line, recording the kinds and numbers of bird species we encountered. During this period 95 species were heard or seen, including such surprises as the great blue heron, sharp-shinned hawk, sparrow hawk, bobwhite, ring-necked pheasant, black-billed cuckoo, belted kingfisher, rufous-sided towhee, and Wilson's warbler. The number of birds in each necropolis varied in relation to the size of the cemetery and the diversity and quantity of vegetation.

Systematic searching revealed 1,195 nests of 34 different bird species. Common starlings, robins, and blue jays accounted for 36.5 percent of the nests, while the less frequent yellow-shafted flickers, song sparrows, catbirds, ring-necked pheasants, and mockingbirds accounted for another 26.6 percent. This was no surprise, but the wide distribution of breeding birds over the study area was unforeseen. Despite the insular aspects of cemeteries in the city, their small size, and the surrounding human development, many birds of varied species were able to raise broods successfully.

In addition to avian habitat, the cemeteries provided adequate niches for a number of mammals. Twenty species were observed, including raccoons, striped skunks, red foxes, woodchucks, red squir-

CARY S. WOLINSKY

Activities Found in 50 Greater Boston Cemeteries During 200 Hours of Study

Activity	*Total Number of People Engaged*
Family gravesite visits	726
Historic gravesite visits	657
Car drivers passing through	323
Pleasure walking	256
Relaxing or sleeping	218
Bicycling	104
Dog walking	40
Athletics, including baseball, football, golf, jogging, and Frisbee playing	35
Games, including chase tag, hide-and-seek, hopscotch, card playing, and setting off fire crackers	21
Drug or alcohol consumption, including glue sniffing and marijuana smoking	18
Feeding wildlife	18
Fishing	16
Berry picking	15
Chipmunk trapping	9
Stone rubbing	8
Gardening	6
Model plane flying	6
Photography	2
Drivers' education	2
Eating lunch	1
Car washing	1
Peeping Tom	1

rels, flying squirrels, opossums, muskrats, and cottontails.

Cemeteries with the essential habitat requirements contained numerous amphibians and reptiles: common garter snakes; stinkpot, snapping, box, and painted turtles; newts and dusky salamanders; common toads, bullfrogs, and green, leopard, and pickerel frogs were among the species found. A variety of fish and insect life was also present.

Some of the wildlife scenarios we observed were the equal of any occurring in a rural landscape, with an added element of excitement because of the setting. Imagine standing in a 3-acre cemetery in south-central Boston, surrounded by 5- to 12-story buildings, and seeing a sparrow hawk deliver a meal of fresh-killed rodent to its young; or walking through a 15-acre necropolis in uptown Brookline and flushing a ring-necked pheasant with her four-week-old brood. We were struck by the ability of these birds to exist in these inadvertent habitat pockets and often wondered how a child from the inner city might feel experiencing similar outdoor adventures.

Only 13 cemetery owners reported wildlife management practices, and these were largely passive and limited in scope. While "chasing stray dogs or cats," "exterminating rodents at cemetery dump," "trapping skunks," instructing workmen to "take caution of all wildlife when working," "chasing off pheasant hunters," and "providing a bird feeder" may be commendable deeds, they are essentially gestures. Only four of the cemeteries could be said to have active management programs. One maintains a bird feeder year round, and two others "leave natural areas" in the form of old fields and uncut hay "for pheasant nesting and wildlife in general." The fourth, Mt. Auburn cemetery in Cambridge, does actually consider wildlife whenever plantings are planned.

We believe most cemeteries are well suited for wildlife habitat management, particularly for birds. Since this land can support a variety of plants, much of it could be easily converted to acceptable, even prime, habitat for wildlife. By providing adequate water, food, shelter, and breeding sites, the numbers of breeding birds can be successfully increased and the activities of transient species influenced. This procedure has been used extensively in Europe and North America to successfully produce game animals for hunting.

Interviews with the managers of 45 of the cemeteries disclosed that 58 percent of the interment sites are publicly owned by town or city governments. Religious organizations (31 percent) and private corporations (11 percent) own the remainder. Public access is allowed in 41 of the cemeteries studied; three limit access to those people who obey the posted regulations. In only one cemetery is access limited to plot owners and family gravesite visitors.

Most of the managers, however, expressed negative attitudes concerning the use of their cemeteries for non-gravesite-visitation purposes and offered obvious reasons. In many instances an activity cannot be tolerated or encouraged because of a lack of adequate facilities or conditions. There may be no roadways or paths for bicycles. Heavy traffic may create a hazard for both cyclist and driver, who may be hid-

JACK WARD THOMAS

Littering and vandalism are cited by cemetery managers as major reasons for not opening their gates to recreational users. Doing so, however, could actually decrease vandalism.

den from each other or distracted by the shrubbery and monuments.

Because of frequent road intersection accidents between cyclists and cars, two cemeteries now refuse to allow bicycles inside their gates. However, we drove over 4,000 miles of roadway in city and town traffic—including many miles of roadway designated by municipal governments as bicycling trails—as well as all existing cemetery roadways, and we decided the latter are far safer for cyclists than the outside bike trails.

This is a matter of attitude and management. Many low-cost preventive measures could be taken to avoid collisions inside cemeteries: welcoming signs at entrances might serve to warn users of the dangers; speed bumps preceding all intersections could serve as slowing-down devices and warnings; and stop signs could be erected. Much of the cost could be recovered by a small user's fee or the expenditure could be considered as public relations. Laws could also be sought to exempt cemeteries from liability for accidents resulting from recreational use.

Similar circumstances prevail when considering jogging, picnicking, stone rubbing, dog walking, or even ball games. A percentage of negative owner attitudes can be explained by the experiences they have had with cemetery users who engage in these activities. Joggers are sometimes indiscreet, roaming the cemetery at large. Picnickers often leave litter behind. Stone rubbers may leave crayon or charcoal marks on very old, hand-carved monuments. Ball games are played without consideration for graveside mourners. Dog owners who allow their unleashed pets to romp over the grounds, defecating and urinating near or on headstones, offend not only plot owners but workmen and other visitors as well.

Most of these problems could be eliminated through innovative management. Some cities today issue permits for stone rubbers, and such licensing could be extended to include other activities. Cemetery officials could confine particular recreational pursuits to designated areas. Dog walkers could be required to leash their animals and confine them to an unused wooded area not frequented by workmen or plot holders. After inquiry at the main office, ball players could schedule their game between the end of a 10:00 A.M. funeral, say, and the beginning of a 2:00 P.M. interment. If entrants were registered with large, colored, number-coded badges, cemetery personnel could more easily control inconsiderate and vandalistic individuals.

Such problems will have to be overcome before cemeteries can be managed as multiple-use areas. But the overriding problem limiting public access to cemeteries, which is less easily solved, is vandalism. Two types—lark vandalism and the less common professional vandalism—were reported and observed in every cemetery, and there seems to be little difference in the rate of vandalism from one municipality to another. Both types are very costly in terms of repairs and replacement of property.

Destinations of Outdoor School Field Trips in Greater Boston Area

Parks	42.9%
Private lands	21.7
Zoos	8.3
Local neighborhoods	8.0
Cemeteries	4.1
Aquariums	3.5
Museums	3.2
Beaches	3.0
Farms	2.3
Other	3.0

Based on 398 teacher questionnaires, from elementary schools to colleges within a one-mile radius of a cemetery. 1971–72 school year.

Examples of observed lark vandalism included destruction of forty hand-carved slate headstones that were more than 180 years old, opening of a 200-year-old tomb and desecration of the remains, toppling of fifteen modern headstones into a marshy area, smearing of paint over monuments, and the scattering of wine, beer, and liquor bottles over some twenty graves and tombs. The lark vandals are usually groups of young people who strike at night with no apparent reason.

Professional vandals are equally destructive. Bronze statues, some weighing more than 1,500 pounds, have been stolen. Almost any resalable item—copper wire, copper pipe, machinery, and equipment—is vulnerable to theft. This vandalism effectively deters a manager or owner from allowing public access to the cemetery even during daylight hours.

Solutions to this problem are critical to the feasibility of multiple-use recommendations. In cemeteries with uniformed security patrols, there is a marked decrease in both forms of vandalism. See-through fencing appears to be a deterrent for many unwanted activities. Some success in control of vandalism is reported by John F. Philbin, executive director for Catholic Cemeteries in Chicago, who has opened 37 cemeteries for multiple use by the public. Old non-see-through fences, which "don't stop vandals anyway," are being replaced "with forms of fencing that are decorative and inviting rather than forbidding." This combination of allowing public access and fence renovation has "decreased the occurrence of lark vandalism." According to Philbin, when children feel that cemeteries are important to them personally, they are very apt to discourage improper use by their friends and report serious violations to authorities.

A second hurdle is the social objection to any use of cemetery space other than as a repository of the dead. This is a deeply held conviction and cannot be ignored. It is ironic that cemetery lot owners in Chicago cemeteries in the 1930s complained of "noisy, smoking, clamoring automobiles" disrupting graveyards. People at that time felt it was disrespectful to motor to a gravesite and suggested a ban on autos, allowing only walkers and bicyclists on cemetery roadways. On the other hand, reports from the mid-1800s tell of many New England cemeteries that were the center of family Sunday socials. Picnicking and grave visitations were combined to make for an en-

Except for the tombstones, Boston cemeteries make idyllic settings for recreation and wildlife. A young man, right, counts bird species for a research project, while the man, far right, is attempting to catch a chipmunk for pet farm breeding stock.

JACK WARD THOMAS

tertaining and enjoyable afternoon.

There are no ready answers to those who consider a cemetery as a place where the only function should be "respect for the deceased." We are convinced that times and demands change, and so should policies. The trick seems to be insuring compatible uses and regulating or excluding those that are not. Judgments as to compatibility are apt to change with such variables as available space, age of the cemetery, layout of the grounds, and amount and type of vegetation.

Since we are dealing with a cultural land-use steeped in centuries of tradition and bounded in law, change could be difficult. Differ-

CHASE
LOVEJOY
SANFORD

JACK WARD THOMAS

In some urban areas, cemeteries provide the only habitats in which cottontails, praying mantises, and waterfowl can thrive.

ences of opinion are certain to arise over such a sensitive land-use, and we implore readers to keep in mind George Bernard Shaw's statement: "You see things as they are; and you ask 'Why?' But I dream things that never were; and I ask 'Why not?' "

Actually, the question of whether cemeteries should be used for purposes other than deposition and honoring of the dead may be a moot one. Our research has shown that there already is heavy human use for numerous other purposes, and when we think about the future, we can be sure that these open and relatively inviolate spaces will become increasingly valuable. Their green vegetation and towering trees amid urban cacophony and concrete will prove irresistible to people seeking a brief respite.

Pressures for readily accessible outdoor recreational land are mounting rapidly. The Presidential Commission on Population has predicted that by the year 2000 this country's population will have increased substantially and a large majority of these people will live and work in cities. Where will they find areas for outdoor recreation? Existing cemeteries will be among the few available areas that could relieve the pressures for open space, provide some adequate wildlife habitat, and improve the quality of the human environment of our cities.

But what has developed so far has just happened with no plan and little view as to where it may lead. We do know that "the times they are a-changin' " and that the burgeoning populations of Boston and other metropolitan areas will need all the open space they can get—from whatever source. Cemeteries cannot be ignored; they make up too much of what is available.

Research and management schemes should be instituted as soon as possible to allow maximum compatible use of these areas. The space crunch is at hand and time is short. ■

ANGEL SOCCOOATO

The Greater Rhea Chick and

Switching partners is an old—and vital—mating practice for these ostrichlike birds of South America. The male gets the offspring

by Donald F. Bruning

When Charles Darwin reached the open pampas of Uruguay and northern Argentina on the voyage of the *Beagle*, the existence of the large, flightless birds he encountered there was already known. Earlier explorers had thought that these gray birds—five feet tall and weighing as much as eighty pounds—were small ostriches, but when specimens became available to zoologists, that notion was dispelled by the great anatomical differences between the species. The birds Darwin saw were greater rheas, and their relationship to ostriches was one of evolutionary convergence—both filled similar niches, the former in South America and the latter in Africa.

As he traveled southward, Darwin received reports of another, smaller flightless bird in the vast, dry hills of Patagonia. Legend has it that Darwin was the first to determine that there were two species of rheas. The story goes that while eating the drumstick of a rhea killed for the pot, Darwin noticed that the thigh bone was different from those of the rheas farther north; the smaller bird is now known as Darwin's rhea.

Darwin's rheas are also distinguishable by their brown feathers bearing white edges, which give the birds a mottled appearance. This smaller species, rarely attaining a weight of more than seventy pounds, has a large range that stretches from the lightly populated, high, arid steppes and scrubland of Peru, Bolivia, Chile, and Argentina to the Strait of Magellan. The greater rhea is confined to the more heavily settled pampas, and the ranges of the two species do not overlap.

The two birds share a social behavior characteristic of less than 5 percent of all bird species: they are polygamous-polyandrous. Reversing the roles of the sexes, the male builds the nests, incubates the eggs, and cares for the young; the female's role is to lay the eggs.

To understand how this reversed role of the sexes operates and determine its evolutionary significance, I have made two extended field trips to the Rio Salado region of Buenos Aires province in Argentina, where I was able to observe the social system of the greater rhea throughout the critical breeding season.

In the winter months, June to September, greater rheas are usually found in flocks of 15 to 40 birds, and up to 70 birds have been seen grouped together. (This behavior—gathering in flocks—probably evolved in the distant past to lessen predation by making it much more difficult for predators to approach.) Because many males live a solitary existence in the winter, adult females and yearlings outnumber adult males in these groups. During this period, when weather conditions are often harsh and food is scarce, the main concern of all the birds is simply survival as they search for whatever plants and insects are available. When spring comes to the pampas in late September, however, the flocks break up and rapid physiological and behavioral changes become apparent as the birds prepare for mating.

Those males that wintered with a flock are the first to leave it, and all males begin to show a striking change. Normally hard to distinguish from females, their plumage now becomes darker. Aggression between males increases and they strut about with head, neck, and chest feathers extended so that they appear larger than they are. Aggressive encounters become even more frequent as competition for groups of females intensifies. No "battles to the death" occur, and as in most other species, fighting is a series of threats and intimidations. The infrequent contacts that take place consist of pushing matches in which the males grasp bills and attempt to push each other off balance. Their necks often become intertwined as the match progresses. The loser of such a bout is able to break off with little physical damage, however, and his only penalty is to leave the immediate area.

Those males that have attained dominance then begin acquiring harems by claiming any females in the vicinity. Such harems typically number from two to fifteen females, and these are defended vigorously against any approaches or displays by other males.

Early in the harem formation, the females continue their daily routine of feeding and sleeping and almost ignore the male as he pursues them. As his acceptance is established, however, and the threats from wandering, haremless males become less significant, the male devotes more and more time and

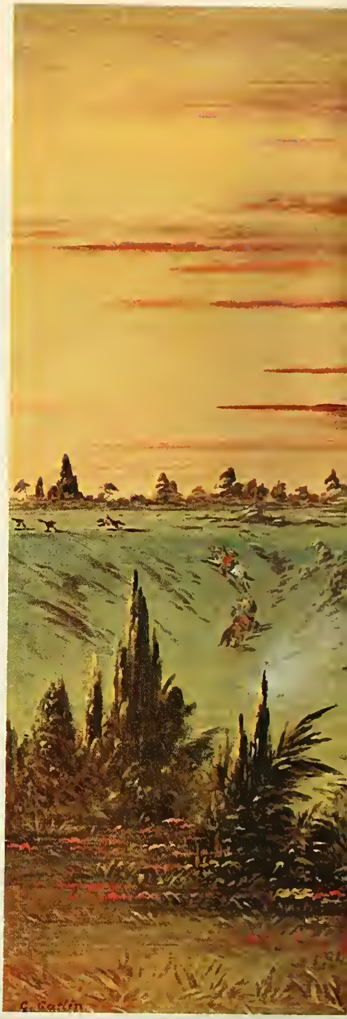
At night and when it rains, the protective male rhea kneels on the ground and gathers the chicks under his outspread wings. Some crawl up his back to nestle in his feathers.

Egg Delivery Route

DONALD F. BRUNING

In the mid-nineteenth century ranchers hunted rheas and used the carcasses for dog food, and peasants killed the birds for meat. These activities, combined with habitat destruction, greatly reduced the numbers and the ranges of both the Darwin's and the greater rhea. George Catlin painted this scene of a rhea hunt in 1856.

DONALD F. BRUNING



OSTRICH CHASE, BUENOS AIRES—AUCA

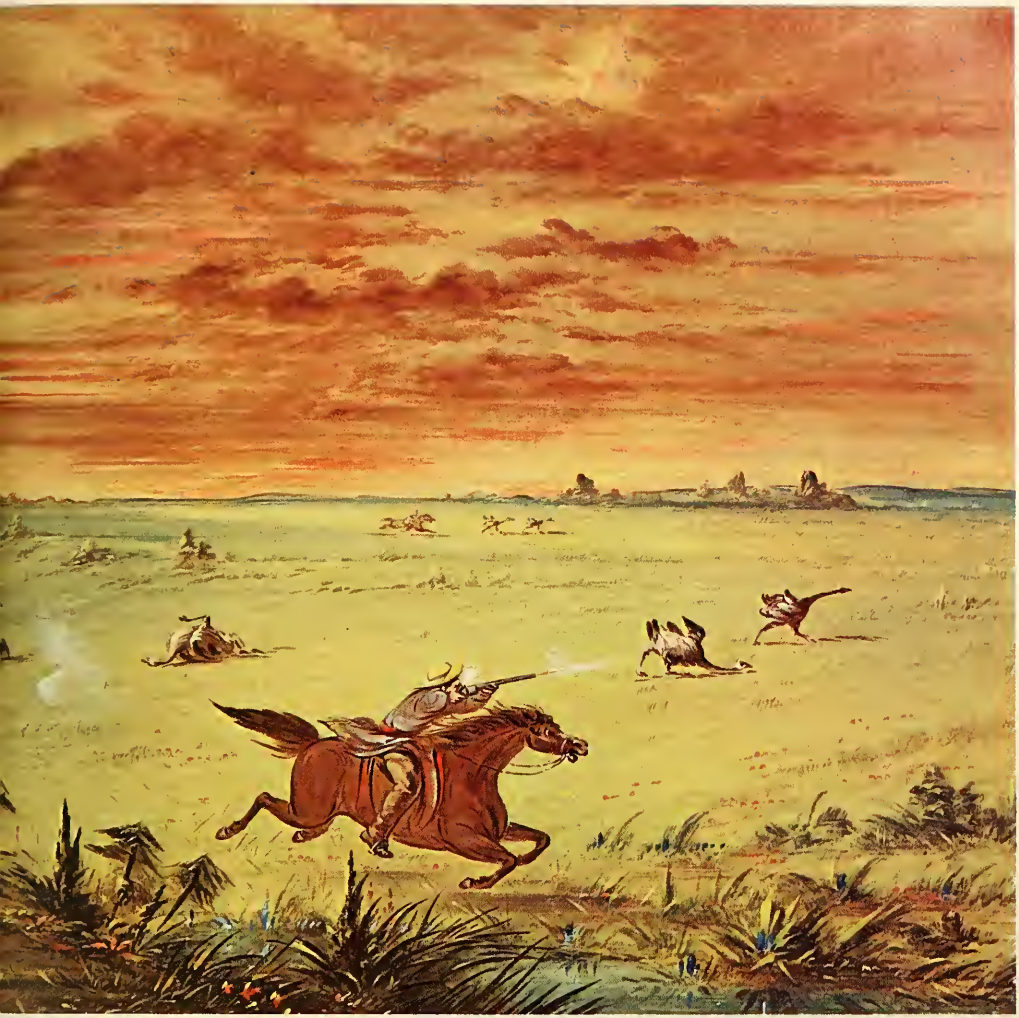
energy to displaying for his females.

In October the pulse of the mating season quickens. In display for his congregation of mates, the male lowers his head, spreads his wings, and slowly walks toward the objects of his attentions. As the frequency of his display increases, the females begin to stand still, rather than immediately moving off to feed as had been the case. Once the male is allowed to approach, his head starts swaying slowly back and forth; as his actions intensify, a group of females congregate around him so that he is displaying with spread wings and swaying head for a semicircle of admirers. As his excitement continues to rise, they may stand in front of him for a minute or two before moving off to feed again.

Eventually, one female remains behind. She sinks down on her hocks and the male seizes her by the feathers on the back of her neck, using his bill to secure a grip while mounting her. After mating, the male drifts toward the rest of his harem, ready to begin the process with another partner.

A male will mate with each of his females at least once in a two- to three-day period and then, while the harem reposes during its midday rest, he busily scrapes out a nest in the ground. After trampling down the vegetation, he scratches out a depression with his feet. The shallow hole is lined and its sides built up with clumps of grass. If a female is ready, she will approach this nest and lay an egg; but if nest building and egg laying are not immediately in synchrony or if the male is not ready for the next big step—incubation—he may build two or three nests within a couple of days before settling down at one.

After several eggs have been deposited, the male remains at the nest while his females continue to wander and feed during the morning and afternoon. His crucial task of incubating the eggs has now begun. The females continue to return to the area of the nest for the next six to eight days for their midday rest, and during these periods most will approach the nest to lay more eggs. Most egg laying is so precisely regulated that the same female can

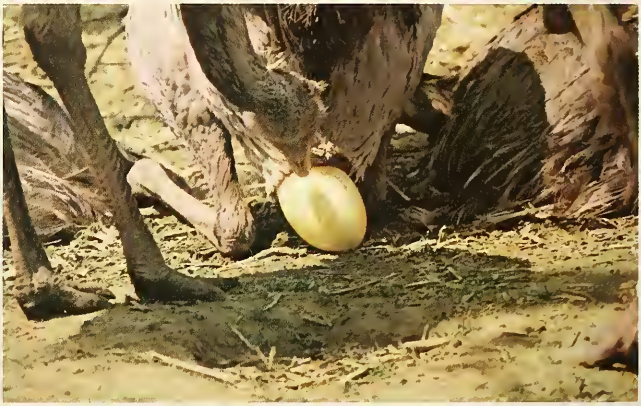


GEORGE CATLIN, PAUL MELLON COLLECTION, NATIONAL GALLERY OF ART, WASHINGTON, D.C.

be observed laying within fifteen minutes of the same time, usually during the hottest part of the day, every other day. The reason for this precision is not known, but the fact that female rheas usually spend an hour resting in the vicinity of the nest during this period makes it the most logical time for egg laying.

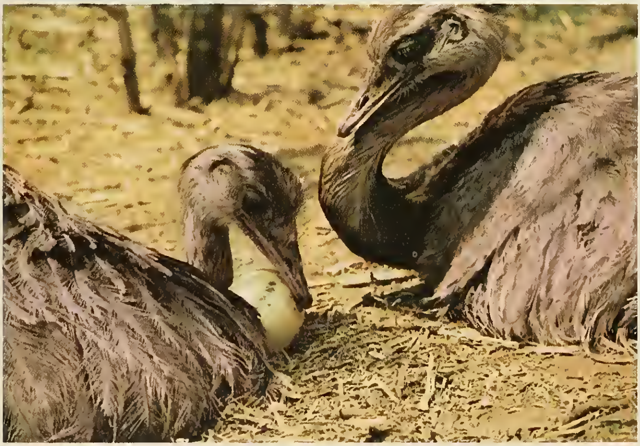
The nesting male becomes increasingly aggressive toward any rhea that approaches. Even a female returning to lay another egg must approach more and more carefully. He threatens her with a loud hissing sound so that she pauses and acts submissively; only after he quiets down does she slowly move in closer to the nest. By the time a female has spent several minutes approaching the nest, the male's aggressive behavior becomes more ritualized and shows elements of the courtship display. His head sways slightly and he may grasp the feathers of the female's neck and back with his bill.

Once the female has knelt down and laid her egg beside the nest, she simply rises and walks away. The male immediately rolls the egg into the nest with his bill. During the early stages of incubation, males will roll any egg in sight into the nest. On barren ground at the New York Zoological Park, males have rolled eggs sixty feet into their nests; but in the wild they must be clearly visible to the male while he is sitting. This limits the distance to a few feet, depending on the height and density of the surrounding



A female carefully approaches the male on his nest and lays an egg, which he rolls into the nest with his beak. Each female in the harem repeats this process until the nest is filled with from twenty to fifty eggs.

DONALD F. BRUNING



vegetation, and some eggs inevitably are lost.

By the time there are twenty to fifty eggs in a nest, depending on the number of females in the group, the male has become extremely aggressive, and the females will have attracted another male who is displaying vigorously. Furnished with this counterattraction, the females stop returning to the first nest and start following the new male, a transition that takes about a week. During this period the second male will have mated with the females and be ready to build his nest. If a female is ready to lay before his nest is excavated and lined, she simply drops her egg out in the open. This happens so often that single eggs rotting in the sun are a common sight.

A group of females lays eggs for one male for approximately seven to ten days and then starts laying for the next male. Less dominant males each get their turn as the season progresses. Each group of females may lay eggs for ten to twelve males during the breeding season.

The male usually does not start incubating the eggs from the first day that he remains at the nest. For the first two or three days he sits on them, but keeps an insulating layer of feathers between his warm body and the eggs so that they may be only one or two degrees warmer than the soil on which they rest. On about the third day the male starts true incubation by allowing his warm skin to touch the eggs and by spreading his wings slightly on both sides to hold in the heat. It is then that he becomes so aggressive toward the females that they will accept the attentions of another male.

During incubation the male leaves the nest for short periods during the warmest part of the day. When off the nest, he eats continually and stops to drink water if it is readily available. Time off the nest seems to vary more with the air temperature and sunshine than with the stage of incubation—ten or fifteen minutes on a cool day but nearly an hour on a hot one.

Only a small number of nests are successful. Many are abandoned if a rotten egg explodes or if a male is disturbed too frequently. Nests are often deserted for no apparent reason, and once the heat of summer really starts in January, most nests are abandoned. These nests belong to the fifth, sixth, or seventh males in the mating order, and the importance of dominance at the beginning of the breeding season becomes apparent as natural selection works against late breeders. Because of the profligate wastage, it is important to the species that as many young as possible are raised by each successful male.

Rhea chicks usually hatch on the thirty-sixth or thirty-seventh day of true incubation. Since the male remains at the nest for only twenty-four to thirty-six hours after the chicks start hatching, there must be mutual stimulation of the eggs to induce synchronized hatching. Such stimulation can result in eggs that may have been laid up to a week apart hatching within twenty-four hours of each other.

Experiments conducted in incubators and under males at the New York Zoological Park, as well as observations in the wild, show that if the eggs are in shell-to-shell contact, those with as much as eight days' difference in age may be stimulated to hatch together. The adaptive advantage of such synchronized hatching is evident: eggs left in the nest when the male leaves with his chicks are usually doomed. Even with this adaptation, many fertile eggs are abandoned simply because they do not hatch within the twenty-four hour period after the first egg has hatched. Some few chicks may pip the egg and hatch after the male leaves the nest if the air temperature is relatively high, but in the open not many get past a pip; predators are almost sure to break the punctured shell and eat the fetus before it has a chance to emerge.

Because of the adult rhea's large size and speed, it has few predators other than man. A chick without the protection of an adult, however, is quite vulnerable to small mammals, such as foxes and opossums, or to caracaras and chimango hawks, two birds of prey that pose the greatest threat. Both of these birds wait patiently for broken or late-hatching eggs or for a chick that cannot keep up with its siblings.

Predators and scavengers descend almost immediately on a nest when the male leaves with his brood. Most natural enemies are unable to break a whole egg and must wait for broken and pipped eggs, as well as for the remains of those that have hatched. Although the thick shells, varying from three one-hundredths to five one-hundredths of an inch, offer protection during those brief periods when the male leaves the incubating eggs untended, they are more difficult for the chicks to break through when hatching.

Once the male leaves the nest with his chicks, he does not return. He is constantly attentive to the chicks as he slowly moves away, feeding continually. The slightest movement or noise brings his head to an upright, alert position. His first response to danger is to call his chicks together and threaten the intruder. If this stratagem doesn't work, he gives an alarm call, which has the effect of scattering the brood in all directions. Each chick crouches to the ground, blending in with the vegetation, while the male goes into a broken wing display to lead the intruder away from the area. If pursued closely, the male will use an evasive zigzag maneuver, letting his wings slowly drift open, then suddenly jerking one wing closed as he executes an abrupt turn. Having eluded his pursuer, he gives the all-clear signal by making a soft, bill-clapping sound, and the chicks come out of hiding to once again cluster at his feet.

During the first two or three weeks the male is extremely aggressive, and other rheas who wander too close are savagely attacked. Using his bill as the main weapon, he usually succeeds in driving away any intruder.

For the first few days after hatching the chicks are most vulnerable. They must first of all keep up with their father, who may wander as much as five miles in one day. At the same time they must learn to feed without being left behind. Caracaras are the biggest threat to the young and constantly wait for an opportunity to catch one alone; aware of this danger, a male rhea will attack any caracara that approaches too closely.

So ingrained is his sense of danger from the air that the male rhea will react to any flying object larger than a butterfly. The noisy, aggressive (but harmless) Argentine lapwing plover is routinely challenged and routed, and even small airplanes attempting to land in the vicinity of the chicks are rushed.

Males with young can be so aggressive that local gauchos frequently take a dog along with them as they ride their horses out onto the open pastureland. A dog's barking will usually intimidate a male, whereas a lone horseman may be charged. Even if the rhea is unlikely to strike the horse or rider, the vicious charge can cause the horse to shy and flee in panic with the frequent result that the gaucho is thrown and must walk home.

Herds of cattle are another big threat to the young chicks. While cattle are accustomed to seeing adult rheas, they are very curious about groups of chicks. All a cow needs to do is bawl and run toward a chick, and in all likelihood the whole herd will come thundering after. The male rhea may attack one cow, but he cannot chase a whole herd away. When the chick calls and tries to run away, it only stimulates the cattle even more, and many chicks are probably trampled in this manner.

The chicks have two different vocalizations, both of which bring the male to their aid, but his reactions to each call are entirely different. The first and less frequently used is the alarm call; this cry is used only when the chick is in immediate danger, and it brings the male charging to the rescue. The second is a plaintive "I'm lost" call, when a chick is separated from the male. He responds immediately to this sound by moving in the direction of the caller with the rest of the chicks following behind.

The lonely, plaintive call of a lost rhea chick is not at all uncommon on the pampas of Argentina during the late spring days of November and December. Since the males are not able to identify their own chicks, and the chicks are unable to identify their parents, lost chicks often end up with males other than their parent. This lack of identity often results in one male leading a brood that ranges from newly hatched to two-month-old chicks. However, if the age difference is too great, the smaller chicks will suffer in two ways: they will not be able to keep up with the older ones and they will not be brooded as efficiently.

Rhea chicks start eating when only two or three days old. Their greatest stimulation for feeding comes from constantly following the male as he slowly moves along pecking at plants and insects. Imitatively, they start picking at clover and other small plants, and soon after, they start chasing the insects that the male and other chicks have stirred up.

As the chicks grow, they feed on an increasingly larger proportion of plant materials. Eventually, as adults, they feed mainly on broad-leaved plants, some grass, and a few

DONALD F. BRUNING

A rich yellow when laid, abandoned rhea eggs, above, bleach rapidly in the sun. Because the male is just beginning to form his harem, the group of females, right, do not show much interest in his energetic courtship display.

insects—grass itself probably serves largely as roughage, which passes through the intestinal tract with only partial breakdown. Adults even feed on thistles, which nearly all other animals ignore.

Growth of the chicks is rapid and when they are three or four months old, they are half to two-thirds of their adult size. With the onset of winter, their rate of growth becomes much slower; by the following spring they are still slightly smaller than the adults. It is doubtful if they reproduce in the wild until they are at least two years old.

From this information, the rhea's polygamous-polyandrous social system emerges as an extremely important adaptation for their survival. Female rheas lay every second or third day; if the female also incubated, she could only lay four to six eggs before the hatchability of the first started to decline. If she started incubating even after the first or second egg, she would still be limited in the number of eggs she could lay because by the fifteenth to eighteenth eggs, the first ones would be starting to hatch. At that point the female would either have to abandon the nest to care for her first couple of chicks or ignore them and continue incubating the remaining eggs. Even if both parents were involved, they would have chicks hatching out over a full month's time. Either the smaller chicks would not get enough brooding or the older chicks would be wandering too far from the parent while seeking food.

Because the males incubate the eggs, females are free to lay many more eggs than in other systems, except those in which eggs can remain viable for long periods even if not incubated. Rhea eggs are like those of most other birds, however, in that their fertility and hatchability decline very rapidly if they are held for more than a week before incubation begins.

If only one female laid for a particular male, once again the problem arises that only four or six eggs could be incubated by the male. Rheas have solved this problem: by gathering a harem, each male incubates as many eggs as possible; yet all eggs in a nest are laid within a week so that the chicks will hatch together and receive the necessary protection and care.

The next step in the rhea's social evolution follows logically. Each male can incubate a clutch of twenty to fifty eggs, all of which must be laid within ten days by a group of females whom the male then drives away. Another male then takes over the harem, and the females lay a full clutch of eggs for him before moving on to yet another male. The result is a system in which rheas can raise the maximum number of offspring. Even if the system is wasteful because of the number of single eggs dropped by females and the number of abandoned nests, it works well for rheas. There probably could have been several other ways of reaching the same goal, but this was the solution that developed in the rheas and it has proved to be successful. ■

DONALD F. BRUNING

FROM THE "CHALLENGER REPORT," VOL. 1, PART 1

On a cold, drizzly November evening in 1898, when any sensible Englishman would have pulled up his collar and hurried toward home and a warm fire, four scientists on leave from the British Museum of Natural History prepared to put out to sea. This expedition—if a few short days on the wintry North Atlantic can be called an expedition—was sponsored by the Fishmongers' Company, the Drapers' Company, and the Royal Geographical Society. Its leader was Mr. George Murray, Keeper of Botany at the British Museum, and his cruise mates included a fellow botanist, two naturalists, a tugboat captain, a navigating officer engaged on two days' notice, a crew unfamiliar with scientific duties, and an artist named Percy Highley.

This assortment of men and sponsors may appear to be a curious mixture for an oceanographic cruise, but in the nineteenth century, oceanography was a young, loosely organized science, and as such was open to the advances of many an enthusiastic amateur and polymath. In the 1870s and '80s, for example, it was not unusual for retired physicians, newspaper owners, princes, engineers, and clergymen to put to sea, and with luck and hard work they brought back new species of sponges and sea urchins or surveyed the plankton or bottom sediments in some picturesque bay or inlet.

Fortunately or unfortunately, depending on your point of view, these informal days ended almost before they began and by the time that Murray and his friends put out to sea, the demands of oceanographic research were becoming more rigorous. As Murray discovered, and was honest enough to admit, good intentions were no guarantee of success.

But mishaps were not on the scientists' minds that November evening, and with high hopes and stiff, cold hands, they loaded the last of their sampling bottles, nets, and lines aboard the chartered vessel *Oceana*, a sturdy—if ungraceful—tugboat. Once the gear was safely stowed, she left her snug berth at the Silverton docks east of London on the Thames River and set off toward the channel and from there toward the west coast of Ireland.

The object of this cruise was to examine the intermediate depths of

Sad Saga of the Oceana

In the early days of oceanography, the road to scientific obscurity was paved with well-intentioned mishaps

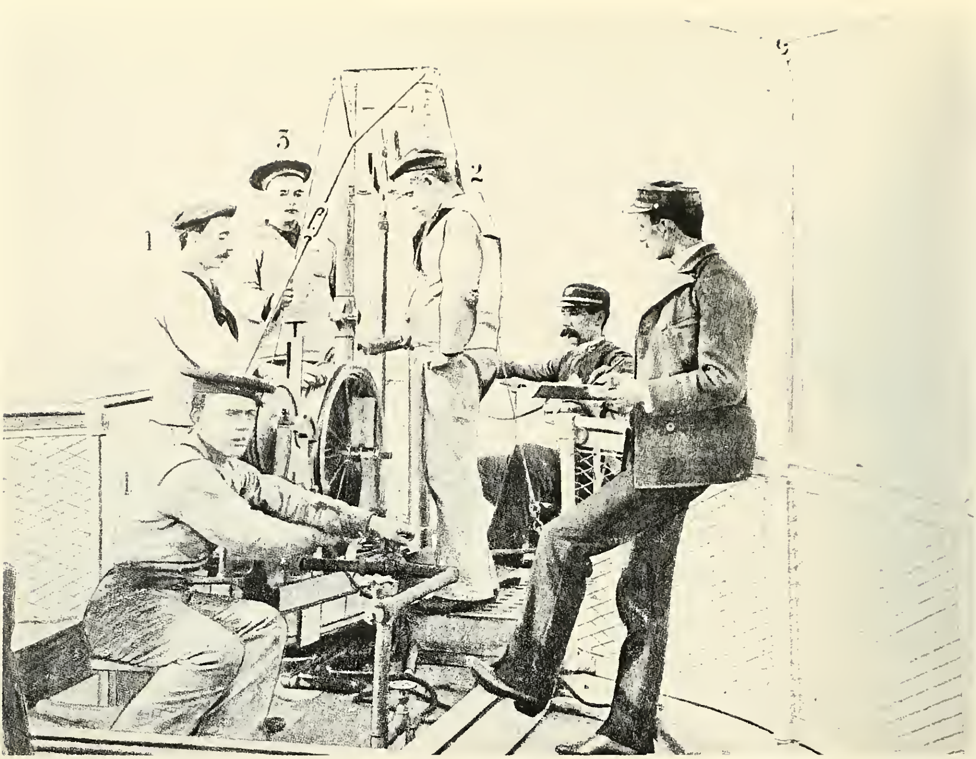
by Susan Schlee

the sea and to determine whether planktonic organisms lived there—a question that had vexed oceanographers for the past quarter-century. Murray explained to his cruise mates that

> it had generally been agreed by naturalists that the surface life extends down to approximately 300 fathoms, and that the deep-sea life rises to about 100 fathoms from the bottom; but two opposed opinions [are] held as to the question, Are the dark depths lying between these zones inhabited, or are they destitute of living organisms? One party, headed by Prof. [Alexander] Agassiz [son of Louis Agassiz and a noted American oceanographer in his own right], contends that these depths are barren of all life; the other, most conspicuously represented by Sir John Murray [best known of the scientists aboard the *Challenger* expedition, but not related to George Murray], believes that they are inhabited.

To resolve this question, Murray (the botanist) saw to it that the *Oceana* was equipped with conical silk townets of conventional design as well as two new models of closing nets. The former would be towed in series on a long cable and would be arranged so as to sample the water at intervals from the surface all the way to the bottom. Murray realized that conventional nets towed at intermediate depths could, as they passed through surface waters with their mouths held rigidly open by metal hoops, inadvertently capture some animals from the upper layers. But "the surface forms, as indicated by those obtained in the surface nets [would be] subtracted from the total catch of the deeper nets" and any remaining animals would hopefully represent the true population of the controversial middle zone.

The use of closing nets, which had begun in the 1880s, provided a surer and more satisfying method of investigation. These nets were lowered tail first or were closed to the passing surface waters in some other manner; then the slowly drifting ship towed them at the desired depth. A weight, or messenger, was slid down the line, tripping a noose and throttling the net for its return



FISHERY BULLETIN OF U.S. FISH COMMISSION, VOL. 16

On a U.S. Fish Commission ship, four seamen operated the Sigsbee sounding machine. The ill-trained Oceana *crew found it a "tough business."*

to the surface. Anything caught in such nets would surely be strained from intermediate waters.

Regardless of the gear being used, the manipulation of quivering, wide-mouthed nets in thousands of feet of water was heavy business, and the men aboard the *Oceana* were pleased to have the loan of a sturdy, steam-powered winch. The machine had been installed amidships, where, unfortunately, it was committed to a single function, that of winding in nets. Consequently, depth soundings could only be taken over the stern of the vessel and would have to be wound in with a hand-cranked winch. But this sort of thing was to be expected aboard a vessel not specifically intended for marine research, and all possible adjustments and refinements had been made by the time the *Oceana* sailed into Dingle Bay, where the scientific portion of the cruise was to begin.

Tearaght Light was still burning when the ship passed out of the bay early the next morning and steamed due west across the continental shelf toward the deeper water that lay above the Atlantic Slope. By mid-morning, when the 100-fathom line had presumably been reached—that arbitrary boundary of the continental apron—Murray decided that to season the nets and the crew a routine set of observations should be undertaken. As always, the first task was to take a sounding.

A Sigsbee sounding machine, a device of American design, was readied at the stern of the vessel and a detachable weight and sediment sampling tube were attached to a wire that ran over and under a veritable clockwork of reels and spools. A sailor with a stopwatch gave the signal, the brake was released, and the lead zipped down into the water. When it struck bottom some moments later, the wire began to run out more slowly—the signal to apply the brake and stop the machine. An odometer recorded the length of wire paid out, and with a minimum of calculations, the men computed a depth of 89 fathoms. Then the reeling in began.

Only two men at a time could crank the hand winch, and the first to offer their services—in fact, to insist upon the privilege—were Murray and the ship's commanding officer, Captain Rickman. The two cranked the heavy iron handles while their comrades stood nearby, enjoying the novelty of the expedition's first station and offering encouragement as the sounding wire slowly spiraled onto a drum. The job was much harder than expected. Murray and Rickman grew warm inside their woolen jackets, their faces reddened, and so heavy did the sounding line feel that they began to joke weakly of improbable deep-sea treasures that must have snagged the line. As they continued to reel in, "their exhausted condition filled the others with dismay," for they faced the prospect of doing their share of reeling in, in much deeper soundings.

At last the sampling tube was sighted coming up through the gray waters, and with considerable relief Murray drew it aboard and extracted from the short pipe a sample of fine sand. The Sigsbee machine was rigged for the next sounding and only then was it discovered that no one had remembered to release the brake that stopped the wire from paying out. Murray and the captain had wound in all 89 fathoms with the reels tightly clamped!

But no matter, the sounding was accurate, and with the depth known, four townets were attached to the main wire at proper intervals and the lot of them were let over the side to stream outward and downward behind the ship. To ease the strain on the laden wire, which twanged like an ill-tuned guitar as the ship rolled back and forth, the *Oceana* had been equipped with "India rubber accumulators of the Admiralty pattern." Like giant rubber bands, the accumulators, stretched between a heavy spar and the block that carried the towing cable, were designed to smooth out the ship's jerks and sudden yieldings, motions that could otherwise kink and snarl the wire. Murray and the others had never seen accumulators in use, but although they watched attentively, "there was never at any time the least evidence of elastic play; in short, there was never the least sign of their being of the smallest use. . . ."

In a way, it was fortunate that the accumulators proved to be dispensable components of the towing gear, for a few days later, when the *Oceana* finally reached the deep-slope waters where the most serious investigations were to be performed, it was found that there wasn't enough wire rope on her drums to allow the townets to trail near the bottom. Consequently, it was necessary to splice 500 fathoms of two-inch manila line onto the cable, but then it was discovered that the new line would not pass through the block attached to the accumulators. There was nothing for it but to stow the Admiralty's device, pass the lengthened line

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TRUSTEES OF THE BRITISH MUSEUM (NATURAL HISTORY)

Despite the many setbacks, botanist George Murray returned from the voyage with high—but false—hopes for a scientific discovery.

over an "old man" block and proceed with caution—but without accumulators.

Shortly before dawn the next morning, the men began to work on one of the expedition's longest, deepest, and most arduous stations. Murray was particularly anxious to set the townets at exactly the right depths, and to do this, both the depth of the water and the drift of any current that could affect the angle of the towing wire had to be ascertained. The *Oceana* was now well out over the continental slope; minute after minute the sounding wire ran down into the sea with a hum that could barely be heard above a rising wind. Bottom was found at 1,835 fathoms, a depth of more than two miles.

Although this time they released the brake, still "it was a tough business getting all this wire in by hand. One hundred fathoms for each pair [of men] was hauling enough, and the combined muscle of the members of the expedition and the ship's company was not much more than sufficient for the work."

The job wasn't made easier by the rolling that had begun, but despite the rough sea and the green water that poured over the rails at the least convenient moments, the sounding line was finally wound in at the cost of great exertion and one remarkably bent crank handle. The museum men, being collectors both by inclination and profession, considered the twisted handle convincing testimony of the rigors of the cruise, and happily agreed to keep it as a memento. It was hastily packed away amid their gear, but the handle was never displayed, for "its appearance so outraged the best professional feelings of an engineer of *Oceana,* that he surreptitiously straightened it again."

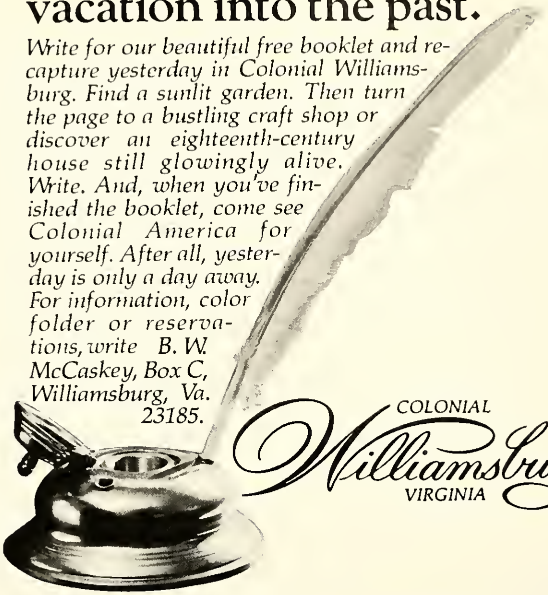
Meanwhile, work was proceeding rapidly on deck, and sailors had stationed themselves fore and aft to calculate the drift of the current. To do this, a sailor in the bow threw a piece of matchboarding into the water, while another timed the wood as it drifted the length of the ship. On this occasion the matchboarding picked to measure the drift was the same piece that had been sent down to 500 fathoms on the previous day to illustrate the awesome effects of deep-sea pressures. That demonstration had failed dismally, for the wood had emerged looking exactly as it had before. Now on a signal from the timer, the piece was dropped overboard. "It instantly sank," and the sailors stared in disbelief. Murray happily explained that the previous day's experiment had compressed all the air spaces in the wood, making it as solid as a piece of metal.

The current was finally measured with a more buoyant piece of matchboarding and the nets were attached to the line. The lowest net was set to tow only 10 fathoms off the bottom "with slender hopes . . . of ever seeing it again."

The string of nets was let into the sea with extreme care and deliberation, for the sea was rough, the accumulators were missing, and the organisms to be captured could be easily crushed into a paste by the bobbing and jerking of the nets. Hours passed while the nets drifted as much as two miles below the ship and it was 1:00 A.M. of the following day before the last of the nets came streaming back over the rail.

"The operation entirely justified Mr. Murray's preference for hauling in by night," wrote Mr. Murray, "since the luminosity of the nets far below the surface [due to the bioluminescent plankton that they were passing through] gave ample warning of their approach—a matter of importance when careful measures for immediate preservation of the contents have to be made."

An unexpected delight was the return of the deepest net with a small quantity of sediment in it. If it had hit bottom, the fine silk net would have burst, but if it had been more than a few fathoms off the sea floor, it would not have sampled some of the ooze stirred by the 60-pound weight at the end of the towing cable.



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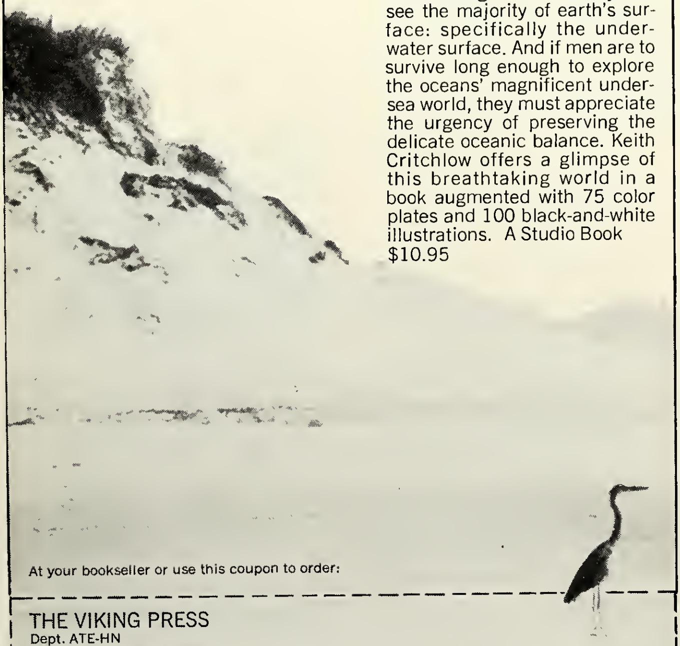

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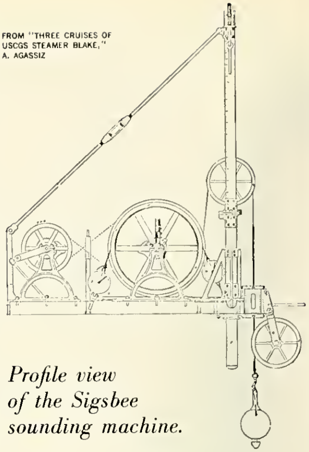

FROM "THREE CRUISES OF USCGS STEAMER BLAKE," A. AGASSIZ

Profile view of the Sigsbee sounding machine.

Once the oozes and animals from all the nets had been sluiced into jars of preservatives, labeled, and stowed in the forehold, the weary naturalists wedged themselves into their narrow, rolling berths for a few hours' rest.

Although the rough weather continued, the crew nonetheless made an effort "to do justice to the claims of the Tanner [closing] net. It was sent down to 650 fathoms, every conceivable precaution having been taken to ensure a successful haul. The apparatus acted as required; the messenger . . . released the constricting cord." But to their intense disappointment, the net came up empty. "It was impossible to resist the conclusion that there is something amiss in the balance of the net, which so tilts it as to seriously interfere with its catching powers. . . . Experiments were also made with the Gray net [the other closing net on board] in which, most unfortunately, a delicate spring broke in the heavy sea . . . and it was impossible to do more than to satisfy the members of the expedition that in it, at all events, the right principle had been discovered for an instrument of this sort."

Murray further reported that the "next day the wind slowly fell, but the sea still ran very high and the barometer continued to sink. Towards evening it began to blow from the north-east, and soon it blew a whole gale from that quarter."

There was hope, especially among the less seaworthy who clung miserably to their bunks, that the storm would abate, but by 2:00 A.M., as the wind continued to rip the tops off the towering waves, it was decided to let the *Oceana* run before the gale and then work around to the sheltering harbor at Queenstown. The vessel rolled and pitched into port where she was confined by the weather for two more days (and where it was learned that the gale had been so strong that it had blown a whole train off its tracks).

The vessel finally proceeded to Penarth in Wales. There she was divested of her scientific trappings and the foursome from the British Museum returned to London with their samples.

"It will take several months to complete the analysis of the contents of the tow-nets," wrote Murray, "and when this has been done, a report of the result will be communicated to the [Royal Geographical] Society. In the meantime there is full confidence that the material obtained will permit of a decisive answer."

But unexpected incidents changed Murray's plans, and the results of the *Oceana*'s cruise were neither published in prominent scientific journals nor used to prove that plankton lives at all levels in the sea. As Murray and his colleagues pored over their jars of plankton, official reports began to arrive from the largest, best-equipped oceanographic expedition that had ever set forth upon the seas. Scientists on the German Deep-Sea Expedition, working under admirable conditions aboard the 320-foot Hamburg-American liner *Valdivia*, were making hundreds of successful plankton hauls. Using newer and more sophisticated closing nets, they made hauls in the Atlantic and Indian Oceans, from the surface to tremendous depths, and at all times of the night and day. The grand results were reported in scientific journals throughout Europe and eclipsed the accounts of previous investigations of the middle depths. Not only did they prove that "no level of the sea is destitute of animal life"; they also showed, by comparison, that the days of the amateur oceanographer were over and that the road to scientific obscurity, like that to hell, is paved with good intentions. ■

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Where Humanity Ends

The Mountain People, by Colin M. Turnbull. *Simon and Schuster, $7.95; 309 pp., illus.*

In the late spring of 1967 I went with five other physicians to Mississippi's Delta, there to visit a number of homes and examine a number of American children. They were black boys and girls; some of them I had known for a long time, almost a decade to be exact. Again and again I had described them as poor, as subject to discrimination, as destined for very little indeed so far as money, power, success go. Now I had the chance to show colleagues of mine what I had been observing: people out of work; people denied the vote, denied the right to associate in public places with their fellow citizens; people continually scorned, insulted, humiliated; people often without money, living in the flimsiest of shacks without proper sanitation, sometimes even without electricity.

Now, too, I could begin to point out for others what I had only slowly come to realize myself: the hunger and malnutrition among those children and their parents, the various diseases they possessed (almost all of them untreated), and in some cases the near starvation that seemed to be observable. And in short time we were all agreed that, despite what each of us had learned in medical school, there *were* vitamin deficiency diseases in those children, as well as severe lethargy, bloated bellies, ankles swollen with edematous fluid, wasted limbs, even an instance or two of what seemed to be kwashiorkor, the last stages of malnutrition.

COLIN M. TURNBULL

So we went back to our homes and thought a while, wrote up our reports, and eventually decided to exercise our rights as American citizens. Off to Washington we went—earnest, angered, confused about what could be done, certain about what we knew should be done, and most of all, naive. By a stroke of good luck Robert Kennedy was a United States senator, and through friends we were able to present our findings to him. The rest is a footnote in American history, and has been documented in a number of articles, perhaps best of all in Nathan Kotz's book *Let Them Eat Promises.* I myself wrote a book called *Still Hungry in America*, and in it are photographs that document, all too substantially and precisely, what words simply fail to tell us at times: the sadness and pain a hungry child feels and somehow conveys—in his eyes or in the way he stands or holds on to someone or keeps his distance.

As I went through Colin Turnbull's extraordinary *The Mountain People*, I began to think of the families I have worked with (or for that matter, now work with) as no longer poor and handicapped by all sorts of social and economic problems, but as fortunate if not privileged. Indeed, words like hunger or malnutrition (used by me so often to describe the children of migrants or of Mississippi tenant farmers or sharecroppers, or Appalachian children, and still on my mind as I presently work with certain Indian

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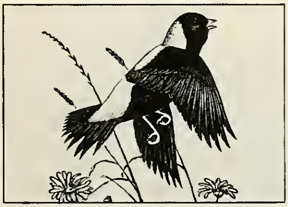

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and Chicano children in our Southwest), seem strangely inappropriate when they also turn out to be used by Mr. Turnbull to describe the Ik, a people who live in central Africa on land that belongs to, or is claimed by, Kenya, Uganda, and the Sudan. Only some two thousand in number, they appear to be a vanishing people.

Once they were knowing, energetic nomads—hunters who understood the terrain they covered and obtained from it a fairly respectable living. Then came "progress," in the name of "modern Africa." A large national game preserve was created, and the Ik were denied the right to wander where they please, to kill animals as they were needed for food. The result is the Ik as they are today—and Turnbull describes them in a book of great narrative power, with a haunting, unsettling, provocative quality that is remarkable in this day of bloated, overindulged adjectives.

In essence we are told how people, living in straits so severe as to defy our imagination, manage to cling tenaciously to what is a literally exceptional kind of life. In so doing, they become in many ways unrecognizable to "us," people with plenty of food, comfortable homes, and a good degree of certainty about the future—tomorrow will also bring three meals, and on and on. They also become a challenge to us, as they most certainly were to our intermediary, the author. One can go through his book and follow the course of that challenge. It is one way to come to terms with his lucid, stimulating account, which is at once concrete and abstract—filled not only with rich direct observations but also with a number of psychological, and at times philosophical, speculations.

Initially we meet an anthropologist deterred. Turnbull did not seek out the Ik as his first choice; he had other plans and interests (the Itusi of the Congo, the Onge of the Andaman Islands), but they could not be pursued. It is getting harder for anthropologists, however sensitive and tactful, and Turnbull is both, to do their work in a world full, as never before, of political disorder and social unrest. The Ik were thus an afterthought of sorts. For a while the author is very much the tradi-

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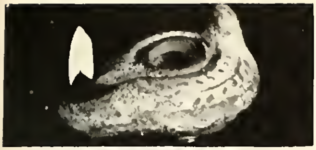

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tional anthropologist going about his work: making contacts, establishing a routine, beginning to get a sense of where he is and what he will do to make a success of his project. Turnbull may write better than many who do similar work. He may have a delightful and moving way of involving his readers in the story he has to tell and the ideas he has to offer. But he set out to study a given people, and he has to make sure we know where they live, how he reached them, and more important, how he established himself as a reasonably effective observer.

In time he began to feel more than the usual dismay or regret or bewilderment any field worker is likely to experience as he goes about watching, listening, and taking notes. He himself makes the comparison with Nazi concentration camps: he was face to face with people under a kind of stress he had never dreamed possible, let alone witnessed day after day. In contrast to the extremes of those camps, this situation seemed less finite, less the product of a specific moment (more than a decade, alas) of political madness.

No one was out to exterminate the Ik. If anything, government officials and others wanted to help them, offer them food, figure out a way to improve their desperate situation—all to no avail. Their predicament was not one that a war could end. Cut off from a whole way of life, they were helpless and often on the brink of starvation by virtue of social change, rather than a despot's deliberate, murderous intent. More than (or less than) helpless, they were virtually inert. Their spirit was gone. They seemed interested only in survival. Children and the old were quickly and often sacrificed to that end. Suspicion was the rule, boredom or indifference the dominant psychological mood—when it was not deception or a degree of self-centeredness that makes our word *narcissistic* seem curiously inadequate.

All of that Turnbull had to comprehend and also, make peace with—if I may put it that way. And to my mind, that is the most interesting and challenging aspect of this part of his career as a talented anthropologist and writer: How to view the Ik, not only as they are, so to speak, but as fellow human

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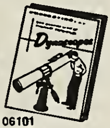

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beings who may have something to teach the rest of us, especially, of all ironies, Americans, generally so well fed and comfortable.

For a while the author is troubled, then saddened. Understandably, he can also turn on his "subjects," be angered by them, judge them as mean, cruel, spiteful and vexing in dozens of small ways, let alone out of some larger (moral) perspective. Eventually, though, the Ik become teachers—in the best field work, that is what always happens. Yet because the Ik live so close to death, because they face the most demanding and unnerving of trials, the lessons they offer are hard to grasp, and may be as ambiguous as those offered by the most subtle and gifted of playwrights or novelists—one thinks of tragedians in this case—from Sophocles to Kafka.

For the author, the Ik finally become an occasion to think about America, not with any great hopefulness. They also serve to make him wonder exactly what man is, as other thoughtful observers have in the past and will in the future. He does not aim to be a theologian or a philosopher, and he is thankfully free of psychological pretensions. Nor is he interested in coming up with theories at any cost, the more the better, as is the case with so many of today's social scientists. He saw people who made him wonder what we basically are. Do our moments of kindness and generosity amount to all that much? Are we really as decent and honorable as we seem or would like to think we are or are absolutely convinced we are? Or is there some awful "essence" in man that the Ik live out more openly, with less self-deceit? Is their behavior as aberrant, so far as "human nature" goes, as it is from the point of view of an anthropologist or sociologist?

Needless to say, the reader does not obtain clear-cut answers to such questions. For one thing, the author has correctly cautioned us against making judgments, living as we do, so removed from the misery and desperation he has witnessed at such length. If we are appalled, we had best not turn on him and call him overinvolved, given to exaggeration or inclined toward unwarranted melancholy. On the other hand, we do have the right to take

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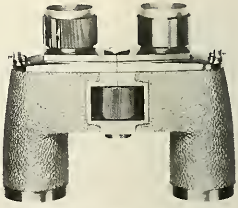

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issue with him when, in the last chapter, he draws comparisons between the Ik and ourselves in a way that suggests that possibly we are also doomed. The Ik have lost all sense of family, and we are said to be headed strongly in that direction. The Ik are fiercely self-centered, and Turnbull describes us as being similarly individualistic to a dangerous extreme.

The Ik seem to incline their observer to a Hobbesian view of man, and to a degree Hobbes's "natural

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man" does indeed seem an earlier version of today's Ik. But Hobbes was constructing a political theory, not claiming to know as a social observer what men were like before the dawn of recorded history. And Turnbull has observed with great care and dedication only certain men—in this instance, hard-pressed beyond any norm and perhaps beyond anyone's comprehension but his. Nevertheless, those he describes as aloof, shut off, thoroughly stingy, or cold, I have the right to see as hurt and almost infinitely damaged, but by no means a measure of man's "basic nature."

The author repeatedly saw and in this book gives us evidence of what one might think of as psychological embers, a glow of the former selves the Ik were. A gesture here, a remark there, a scene on one occasion, an incident on another: they may be few and far between, but they are moments in which kindness or affection or simply human anguish comes across.

I am a psychiatrist, trained to be wary, if not downright suspicious, of people and their motives. Yet as I read this account of the Ik I saw them as people grimly, wretchedly, devastatingly debased, not as rock-bottom examples of what we all are underneath, but as people cut off from what most of us are at least trying to be, our constant failures notwithstanding: affectionate toward others as well as self-regarding, generous as well as greedy, reflective as well as driven or impulsive. The work of psychologists like Piaget shows how basic it is for children to explore and try to understand their world, to reach out knowingly as well as cravenly. Yes, children can be warped, maimed, turned into the "bands" of Ik boys and girls this book describes. But is that disaster—an ironic version of Conrad's "the horror, the horror"—evidence enough for the kind of psychological and sociological judgments the author is understandably tempted to make in this fine book? Various readers will obviously have their distinct answers to such a question and the many others prompted by this book.

I can only say here that Colin Turnbull has earned every bit of discussion his book generates; in addition he has earned our gratitude for an exemplary stint of work, set down in such a way that one shudders, stops, and thinks about the most universal of issues, and at times looks at the whole world differently.

Robert Coles is a child psychiatrist on the staff of Harvard University Health Services and the author of Children of Crisis. *He is now in New Mexico working with Indian and Chicano families.*

TO LIVE ON THIS EARTH, by Estelle Fuchs and Robert J. Havighurst. *Doubleday & Company, $8.95; 390 pp.*

To attempt to describe the educational situation of all American Indian peoples—from the Everglades of Florida to the tundra of Alaska, from the isolation of the southwestern deserts to the polyethnic densities of Los Angeles, from the highly assimilated to the culturally conservative, from the impoverished many to the wealthy few, and on and on—is to beggar the hyper-

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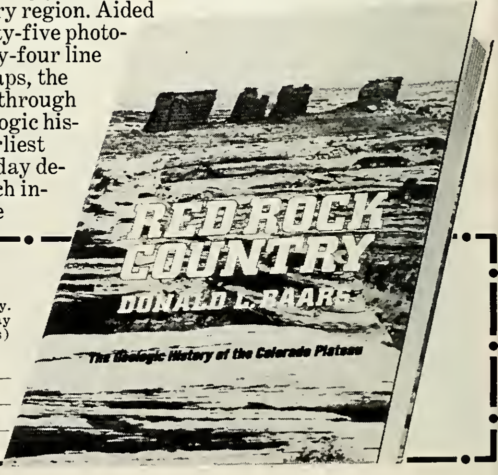

bole of the keynote speaker at a political convention. Even within what purports to be a single tribe, the diversity and heterogeneity must be experienced to be believed: thus, the officially recognized Osage Tribe contains wealthy people who are mostly or entirely white, while numerous persons of unimpeachable Osage heredity are excluded; the official chief of the Oklahoma Cherokee is an oil magnate, while most of the Cherokee who use the language and continue the rituals are impoverished. To encompass the diversity of educational experiences of all Indian children, a large and complex project was initiated several years ago. Included on its staff and administration were both Indian and white personnel. Now the findings of their investigations are set forth in this volume, which of necessity has much of the character of a miniature encyclopedia.

Fuchs and Havighurst describe and document the complex facts of Indian education in straightforward prose. They cut away some academic underbrush and decisively refute certain theories about the poor mental health of Indians (John Bryde). They expose the exaggerations of Indian suicide rates. Test data are reanalyzed; new and different tests administered; suicide rates are assembled by age and sex. The situation of Indians remains bad, but their children are coping.

With its abundant, relevant tables and forthright descriptions, this book should be most useful for the planner and for general reference. Some sections are extraordinary in their evocative detail. Three pages on Indians in Chicago (excerpted from the project report by Fuchs, George D. Scott, et al.) present their problems with a clarity and simple pathos rare in the literature on urban Indians. At the opposite ecological pole, the description of the remote Alaskan villages given by John Collier, Jr., is equally disturbing because the situation described is so clearly colonial.

Fuchs and Havighurst's investigations confirm that most of the educators who confront Indian children are ignorant of, and indifferent to, their distinctive cultural and linguistic heritage. One possible remedy would be via Indian representation on school boards, but in

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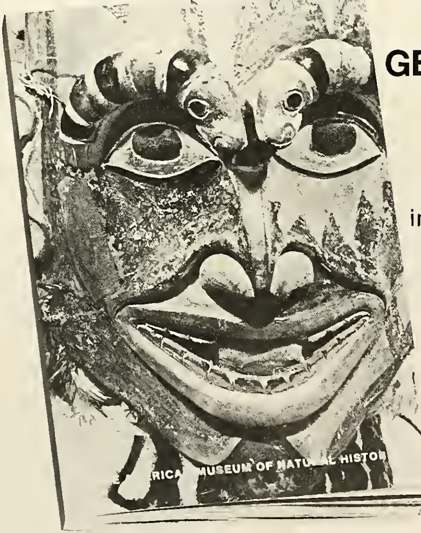

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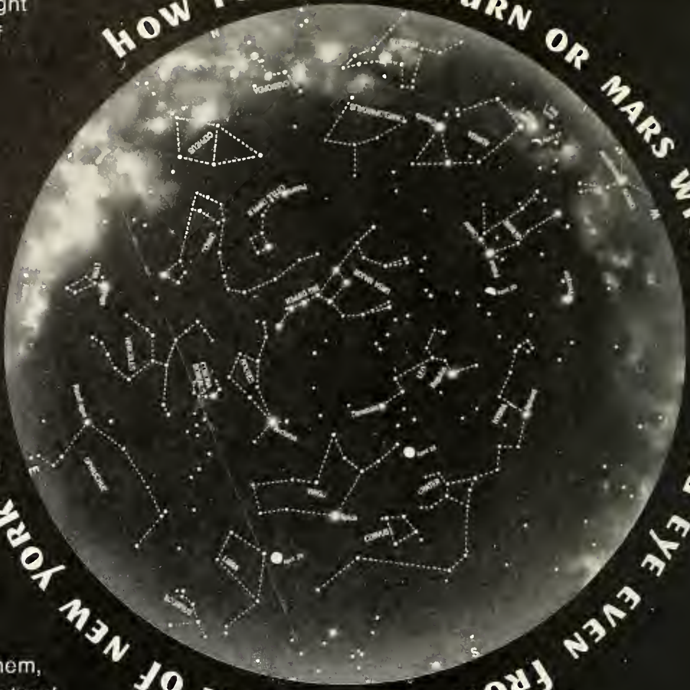

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fact, even where the Bureau of Indian Affairs has instituted Advisory School Boards, these seldom exercise any effective influence. Besides, an increasing proportion of Indian children are attending public schools, and these are more resistant than the BIA to the influences from the Indian community, even as they balance their school budgets through the incorporation of federal monies for the special education of Indian youngsters.

The bright hopes on the horizon continue to be the schools operated by Indian administrations: Rough Rock (elementary), Ramah (secondary), and the Community College among the Navaho; Rocky Boy among the Montana Cree. To the credit of the authors, there is no attempt to gloss their failings, but then in a fair depiction of national Indian education, there is scarcely any need to do so. Whatever their faults, the situation of the children who attend schools with Indian administrations is far better than the norm visible in this report.

ROSALIE H. WAX
The University of Kansas

PITSEOLAK: PICTURES OUT OF MY LIFE, from recorded interviews by Dorothy Eber. *University of Washington Press, $9.95; 96 pp., illus.*

Cape Dorset is a name well known to admirers of contemporary Canadian Eskimo art. The carvings and the graphic art produced in this small Baffin Island community have an international reputation.

Pitseolak—whose sons tell her she is about 70 years old—is one of the most imaginative of the Cape Dorset artists. Her whimsical animals and birds, spirits and monsters, are a delight. Sometimes she portrays, from a woman's point of view, the traditional Eskimo camp life in which she grew up and lived much of her married life: women traveling, fishing, sewing, playing ball, backpacking their babies. But even the figures in these documentary pictures are seldom quite what one would expect to see in life: a four-legged bird perches atop an igloo in a camp scene; a woman with a doll stands on top of a caribou; another woman goes on her way to fish, crowned by a crested bird.

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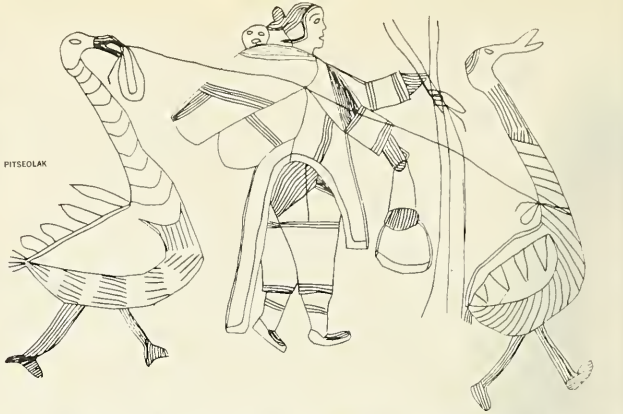

PITSEOLAK

Pictures Out of My Life brings together a number of these drawings, and at the same time lets us look, for a moment, into the mind of their creator: "I did not want to leave the fish spear alone; that is why I put the bird on her head." Pitseolak tells us a few of the thoughts, feelings, and memories that are the raw material of the pictures, as well as her reasons for putting them on paper. Her art has been her bread and butter in her old age, but more than that, it has been a tie to life: "After my husband died I felt very alone and unwanted; making prints is what has made me happiest since he died."

Art, however, is not a pure distillation either of memory or of imagination; it, too, is subject to external influences, and Pitseolak reveals what some of these have been in her case, and in Cape Dorset, generally. She speaks of the encouragement that she and other artists were given to draw "the old ways," to draw fantasies, and to use bright colors: "[Jim Houston] told people to draw anything, in any shape, and to put a head and a face on it." She speaks also of the influence of other Cape Dorset artists: "[Kiakshuk] did real Eskimo drawings . . . and I really liked the way he put the old Eskimo life on paper. I used to see Kiakshuk putting the shamans and spirits into his work. . . ."

It is too much to call this book Pitseolak's life story; rather, it is a tantalizingly small glimpse of what that life, spanning two eras, must have meant to her. At the same time, her observations are remarkably frank, considering the circumstances under which they were recorded: three weeks of daily interviews, through an interpreter, with a comparative stranger. Mrs. Eber must certainly have been as skillful and sympathetic a listener as Pitseolak was an articulate and courteous informant. The book is like a conversation with Pitseolak, and one finishes it wishing to have many more such conversations.

I was pleased to see the bilingual, English/Eskimo text; surely Eskimos will be as interested as we are in what Pitseolak has to say. Moreover, since almost all Canadian Eskimos are literate in syl-

PITSEOLAK

labics, it is high time that an effort was made to broaden the scope of Eskimo literature beyond newspapers and religious books.

At the same time I have some questions about the translation. Although the English text often corresponds very well to the Eskimo original, there seem to be occasional discrepancies. (The lack of pagination—another minor annoyance—makes it difficult to refer to specific instances.) When talking about the value of dogs, Pitseolak says, according to the English text: "They were clever and dangerous, too. . . ." I cannot find that phrase in the Eskimo text. On the other hand, when Pitseolak is praising the work of her fellow artists, I think the Eskimo text mentions two names that do not appear in the English text. At other points I question the choice of word in the English translation: *ivalut*, used as sewing thread, is not "caribou skin" but caribou sinew; an *angaqqua* is not a "spirit" but a shaman—it is translated in both ways here. Pitseolak does not say that her husband Ashoona was "an inland hunter," which would imply that he didn't hunt sea mammals; she says that he hunted well, inland: *nunami angunasuatsiammat*. And so on. I wonder also what accounts for the fact that some of the Eskimo names are spelled in different ways at various points in the Eskimo text. The most striking example of this is the name of Pitseolak's son, which in English is Namoonie. In the Eskimo text his name is variously spelled: Naumanai, Nauminai, Namunai, and Namuina. And why is *mukluk*, the western word for "boot," everywhere substituted in the English text for the eastern word *kamik*, which is used in the Eskimo text? A *kasigiak* (or *kasigiaq*) is a harp seal, and use of the latter term in the English text might have made more sense to English-speaking readers.

These are small deficiencies, however, in an otherwise charming and attractively produced book. We can only hope that Pitseolak will follow her inclination and "if no one tells me to stop" will continue to draw "even after I am dead." I am sure no one will tell her to stop.

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Problems of Relative Growth. J.S. Huxley. Dover Publications, Inc., New York, 1972.

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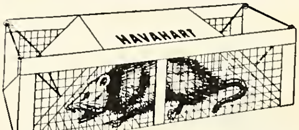

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Celestial Events

by Thomas D. Nicholson

The Sun and Moon The sun crosses the Equator on March 20. Moving eastward (to the left) along the ecliptic (the sun's apparent annual path in the sky) takes the sun more northward during March, until it finally arrives over the earth's Equator, at the point called the vernal equinox, at 1:13 P.M., EST, signaling the beginning of spring in the Northern Hemisphere. While equinox means "equal nights," the tables for that day, at latitude 40° north, for example, show sunrise at 6:04 A.M., sunset at 6:12 P.M. This makes the day 12 hours 8 minutes long, and the night 11 hours 52 minutes.

From mid-March until the full moon on March 18 moonlight brightens the evening sky from dusk until well past midnight. Thereafter, the moon rises progressively later after sundown, but remains through dawn. Last-quarter is on March 26 and new moon, when it passes between earth and sun, is on April 3. Start looking for the early crescent moon in the evening sky by April 6, and you should be able to follow it each clear night thereafter as it grows to first-quarter on the 9th, then appears each evening higher, brighter, and larger as the waxing gibbous moon after the 9th.

Stars and Planets The early evening sky now contains the best stars of two seasons: winter stars in the west, setting between dusk and midnight, and spring stars in the east, rising higher as the night grows older. Orion and its associated stars are brilliant in the southwest after dark. The Big Dipper is high above at the same time, almost overhead, and it is easy to find Leo beneath its bowl.

Jupiter and Mars can be seen in the morning sky each day, in the southeast among the dim stars of Sagittarius and Capricornus. The two planets are very close at the beginning of the period, even closer on April 6, when they are in conjunction, and still close but separating at the end of the period. Both planets are moving east (left) through the stars, Mars more rapidly. It catches and passes Jupiter in early April.

March 20: The sun arrives at the vernal equinox and spring begins in the Northern Hemisphere at 1:13 P.M., EST.

March 25: The moon is at apogee, farthest from earth.

March 26: Mercury, having passed between earth and sun, begins to move eastward (left) among the stars, its direct motion.

March 28–29: On the morning of the 28th, the waning crescent moon rises first, followed by Mars and Jupiter. On the 29th, about three hours before sunrise, they rise almost together. Until dawn you will see Jupiter below and nearer to the moon, Mars to the right and dimmer.

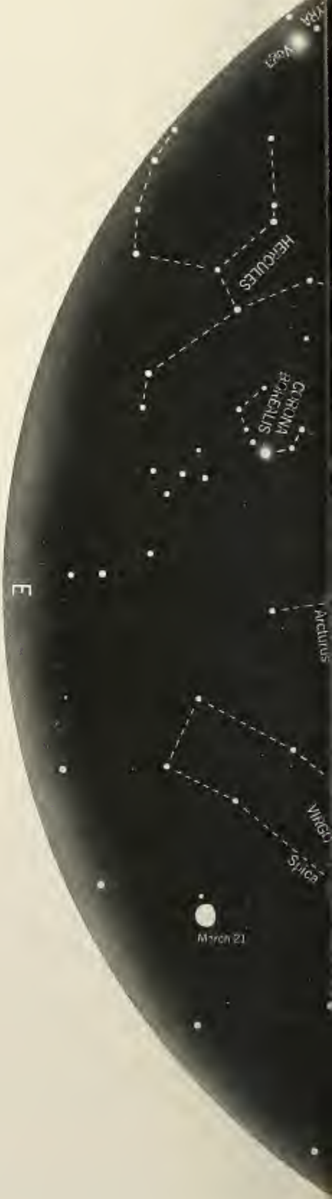
April 1: Mercury is in conjunction with the moon, but invisible in the morning twilight.

April 5: The moon is now nearest earth, at perigee.

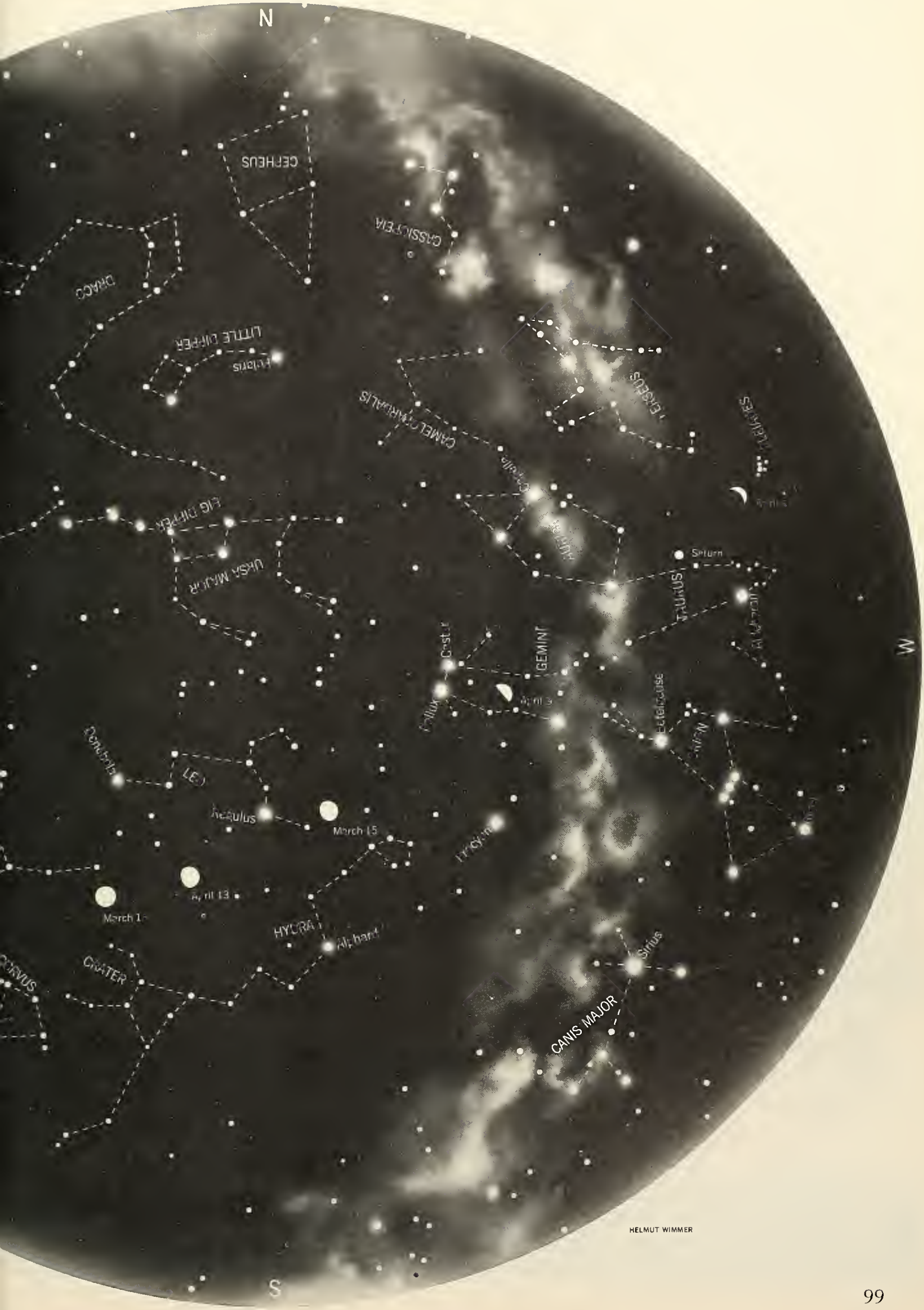
April 7: Saturn is the bright object near the crescent moon, over in the southwestern sky after dusk this evening.

April 9: Venus is at superior conjunction, passing the sun on the far side as seen from earth. A morning star since last summer, the planet now moves to the east (left) of the sun, entering the evening sky.

April 10: Mercury is at greatest elongation (west) in the morning sky. This is an unfavorable elongation. The planet rises too late and remains too low in the morning twilight to be visible.



★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:25 P.M. on March 15; 9:20 P.M. on March 31; and 8:20 P.M. on April 15; but it can be used for about an hour before and after these times.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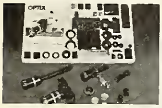

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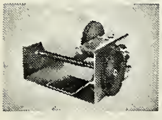

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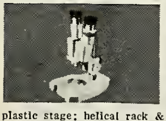

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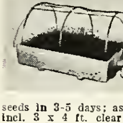

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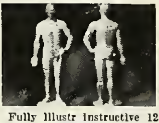

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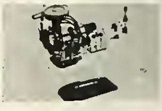

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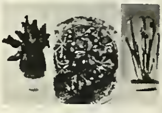

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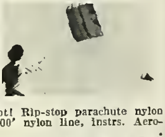

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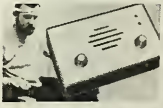

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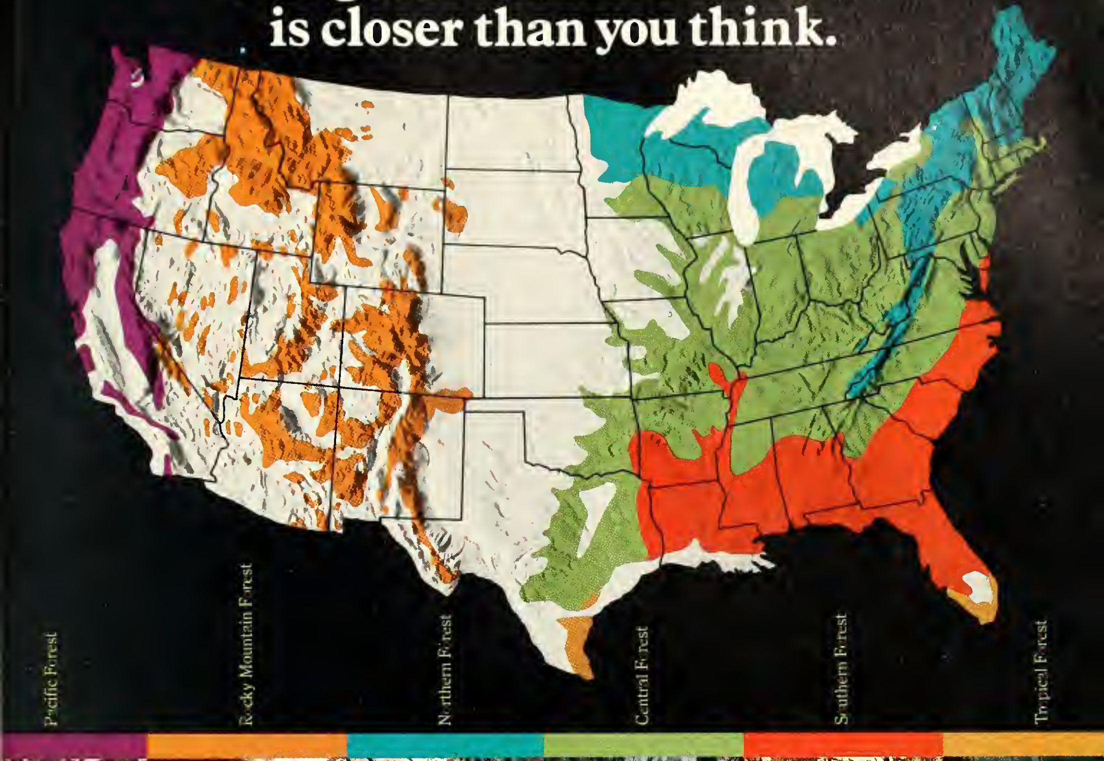

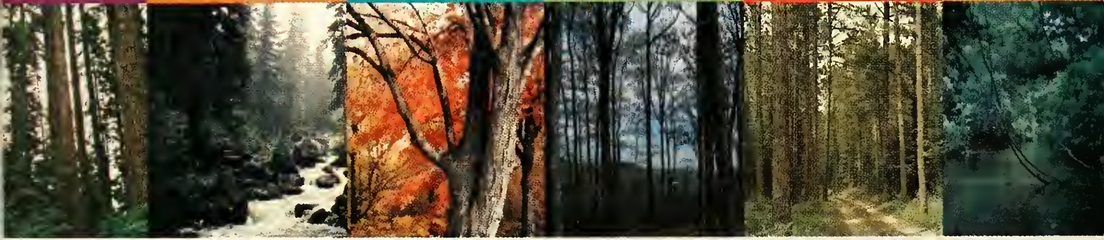

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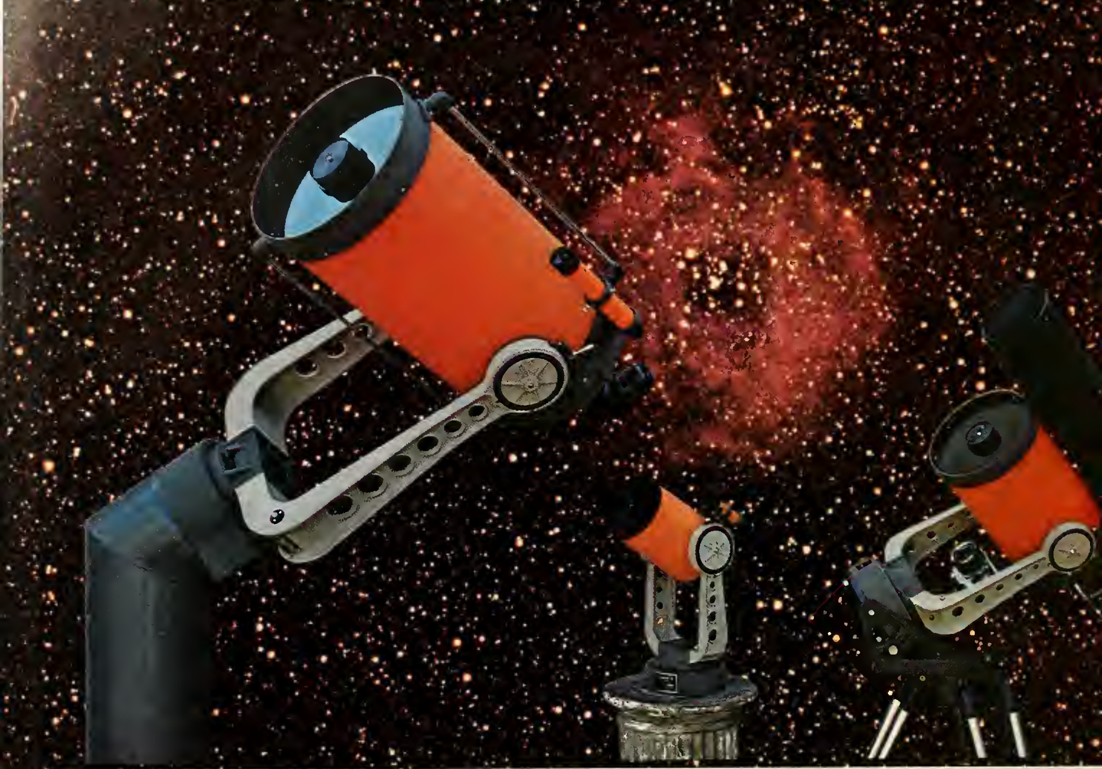

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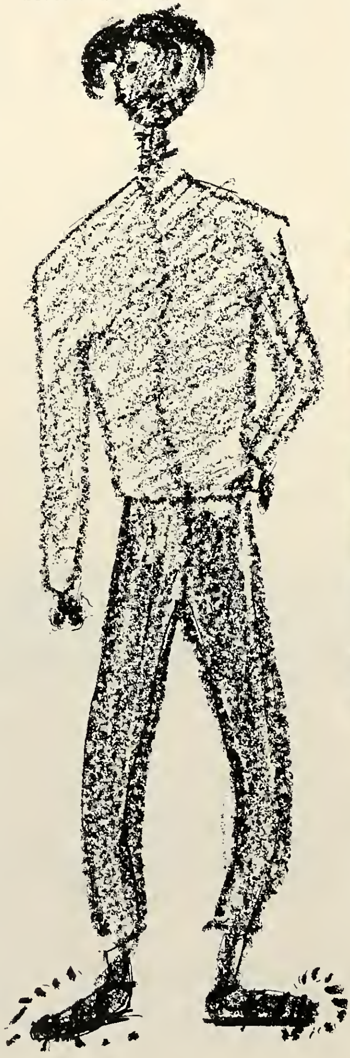
Authors

From his home in southern California, Raymond B. Cowles can see the chaparral-covered foothills where, for decades, he has studied animal life. Having fought fires in the California mountains, he at one time shared the antifire position of many foresters. But his attitude changed when he began to study the response of wildlife after fires. Populations would flourish in the early years after a burn: then diminish as the thick brush vegetation took over the land. His allegory about the reign of Smokey Bear conveys the gist of many of his lectures at the University of California, Los Angeles, where he is now professor emeritus. Cowles was born in South Africa, and has returned there many times to study African mammals. His *Zulu Journal: Field Notes of a Naturalist in South Africa* was published by the University of Southern California Press in 1959.

While working in a vegetable garden in South Carolina last spring, Jecon Gregory noticed some butterfly eggs on a butterflyweed. He patiently watched and sketched as one metamorphosed into a monarch butterfly.

Gregory has been a homeless, inquiring wanderer since he was orphaned in Malta during the Second World War.

After having lived in Europe, North Africa, and the Middle East, he began his North American sojourn seven years ago. He says he does "without some of the things that have come to be considered parts of the human makeup—a house, car, shoes, family, and (for most of the time) a job. He has the ability to represent "things" on paper, and a "fondness for knowing and naming the stars, the plants, and other members of the natural world." His autobiographical book *History of a Nation of One* was published in 1969 by Harcourt, Brace and World.



Jecon Gregory

Peter T. Furst first became interested in the peyote pilgrimages of the Huichol Indians during a field trip to western Mexico in 1965. He has continued to study the traditional use of hallucinogenic drugs among American Indians and is presently researching the relationship between culture and the use of hallucinogens among various Indian tribes of Central and South America. Another of Furst's interests is pre-Columbian art. Furst, who is chairman of the Department of Anthropology at the State University of New York at Albany, recently edited *Flesh of the Gods: The Ritual Use of Hallucinogens,* which was published by Praeger Publishers in October, 1972.

Peter T. Furst

A pioneer and, through his books and television programs, probably the best-known underwater explorer, Jacques-Yves Cousteau is

Jacques-Yves Cousteau

currently studying marine life in the Antarctic. A coinventor of the aqualung, he has also helped develop a number of other devices and techniques that enable man to work in the sea. Cousteau's observation of the mating habits of squid occurred during his study of the migratory patterns of gray whales off the coast of lower California.

The coauthor of "Last Dance on the Mating Ground," **Philippe Diolé**, is a diver, archeologist, and journalist who has written numerous articles on marine exploration. His book on underwater archeology, *4000 Years Under the Sea*, was one of the first on this subject ever published.

Since their first trip to Yugoslavia in 1961, **Roberta Strauss Feuerlicht** and her husband, Herbert, a sculptor, have been studying the history, archeology, and ethnology of the Balkans. They have crossed the Balkans five times, researching and collecting folk music, costumes, paintings, and craft items. On their latest trip, they joined in the dancing at a traditional Macedonian wedding, below. Roberta Feuerlicht, the author of fifteen books, is currently writing one on the Sacco-Vanzetti case.

Roberta Strauss Feuerlicht

John Goddard, who died recently in Africa, was an authority on the ecology and behavior of the black rhinoceros. His last position was that of research zoologist with the Luangwa Valley Project in Zambia where he studied the role of scent and the habit of kicking dung piles in the demarcation of the animal's home range. The aerial censuses he conducted over Tsavo National Park in Kenya during 1967 and 1968 provided the first accurate population counts of black rhinoceroses, and he was among the first to point out the threat of heavy elephant concentrations to rhino survival. Before focusing his research on the black rhinoceros, Goddard was a biologist with the Fish and Wildlife Branch of the Department of Land and Forests in Ontario, Canada.

The Russian Revolution made an expatriate of Siberian-born **Nicholas T. Mirov**. He earned his B.S. degree in 1916 at the Imperial Institute of Forestry in what was then called St. Petersburg, Russia, but completed his formal education in the United States, receiving a Ph.D. in plant physiology in 1936 from the University of California at Berkeley.

Nicholas T. Mirov

Long associated with the U.S. Forest Service, from which he is now retired, Mirov was awarded the agency's first gold medal in 1958. A life-time research associate at Berkeley, he has written more than 100 articles on pine trees and related forestry subjects, including "The Pines of Ravenna," *Natural History*, January, 1971. His article in this issue is part of his autobiography, which he is currently completing.

At Random by Alan Ternes

Once you start thinking about a name, you can really get caught up in it. Even the Bible says that "a good name is better than precious ointment." So I have been wondering of late about the name of this magazine—*Natural History*. How did we come by it? What does it mean? Is it good or bad medicine?

Natural History. Or Natvral History, if you mount it in bronze over The American Museum's entrance. It certainly seems dated. Maybe we should change it to be in step with the times. Yet the recent fates of *Look* and *Life*—two punchy names—are worth pondering, especially when *Natural History* and a number of our sister magazines with antique names, such as *National Geographic* and *Scientific American*, continue to march along in vigorous old age (*Natural History* was 73 last month). Maybe we should look deeper before we think of changing our "good name."

This magazine, obviously, is the immediate namesake of The American Museum of Natural History. But a visit to the dusty archives of the Museum is discouraging. One letter shows that on December 30, 1868, nineteen eminent New Yorkers, including Theodore Roosevelt and J. Pierpont Morgan, wrote to the commissioners of the new Central Park:

> A group of gentlemen having long desired that a great Museum of Natural History should be established in the Central Park, and having now the opportunity of securing a rare and very valuable collection as the nucleus of such Museum, the undersigned wish to enquire if you are disposed to provide for its reception and development.

But as one contemporary noted, only four of the nineteen signers knew "anything" at all about natural history or the purposes of a natural history museum. One of the signers later wrote that the group felt a natural history museum "would be a good thing for the city to have." This seems to make the magazine's title little more than the offspring of a "good thing."

Another letter in the archives drew me away from that depressing thought. It said the founders of The American Museum felt strongly that New York City should have an institution to match the great natural history museums of London and Paris. This meant that I could claim that *Natural History*'s title descends from the scholarly Continental tradition, that it is tied to such eminent naturalists as Darwin, Linnaeus, Buffon—even to Pliny the Elder and his great 37-volume *Historia naturalis*.

It also meant that I could use our new micrographic edition of the *Oxford English Dictionary* to find out what the name really means. With the big magnifying glass I finally located the word *natural*, which has two and a half pages of definitions. With great scholarly anticipation that I would unravel the mystery of this magazine's name, that I would finally be able to tell its loyal readers about the dignity and significance of the venerable title, I started reading. A "natural," the *OED* states first, "is a native of a country." We do run anthropological articles, but the first meaning didn't make much sense. Next definition: "One naturally deficient in intellect," as in "a natural fool." I quickly moved the magnifying glass a few inches: "In a purely natural condition, not altered or improved in any way . . . in a naked state." That didn't say much for our editing. I peered into the magnifying glass again: "The genital parts." As Bulwer wrote in 1650, "They button up the naturals of Mares."

I never did like reading with a magnifying glass. And sometimes I think, after forty years of stumbling through it, that I never really liked the English language either.

In quiet desperation, I turned to an 1858 edition of M. Besherelle's *Dictionnaire National*. On the title page the editor declares that the work is a "monument élevé à la gloire de la langue et des lettres françaises." You just don't find that kind of statement in the *OED*. Such a man, I hoped, would not go rambling on about naked fools and genitals.

My faith in the French was not unfounded. First, I learned that *history* comes from a Greek word meaning examiner or explorer. And that in French the word *history* is not limited to the past, but "in its most general sense, the term applies to everything which is in the realm of experience; the present and the past, all the phenomena which take place in space." Furthermore, *natural history* is the "science which studies forms and diverse parts" of the surface and interior of the earth, that it is the study of the "structure and function of living beings" and is involved in the classification of natural bodies. And this talented editor ends the definition with a lovely quote from the Comte Georges Louis Leclerc de Buffon himself: "Natural history is the source of the other physical sciences, the mother of all the arts."

After a definition like that, I would have a hard time finding a better title for this magazine. I guess we'll keep our "good name."

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Colorado

Smokey Bear-

DAVID MUENCH

Meets Satan's Wife

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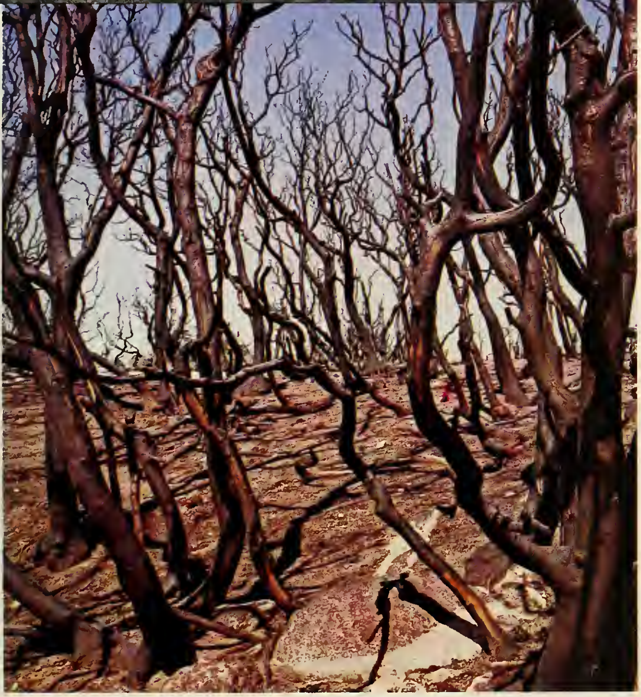

DAVID MUENCH

In an allegorical tale set in the green foothills of California, an ecological demi-paradise rises from its own ashes

by
Raymond B. Cowles

Today the little California village of Chaparral is a model of architectural planning, neatness, and beauty. Since its total destruction by fire only a decade ago, Chaparral has been wholly redesigned by the best architects and city planners. Its people now realize that some clouds may indeed be lined with silver, although theirs were greasy black, shot through with tongues of orange flames.

Chaparral nestles in the foothills that fringe its verdant valley—called La Palma del Dios by its Spanish land-grant owner. Comfortably beyond the chill Pacific fogs and winds, yet well below the rain-gathering mountains, the town is safe from the blistering inland heat farther eastward and the snowy winter cold only some 4,000 feet above. No place in all of California is blessed with a more congenial climate. Except for man-made problems, it is the perfect Shangri-La.

Since its birth as a single general store in 1850, the village has served the needs of the farmers whose orchards and fields flourished on the "bottomless" alluvial soils. Throughout millennia, annual rains, which often followed patchy, lightning-set mountainside fires, had lightly skimmed off charcoal, silt, and charred twigs, and laid the black mixture—fertile layer over fertile layer—on the valley floor.

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Water was never wanting. Even in occasional drought years it flowed underground, fed from melted mountaintop snows to the many artesian wells, or in innumerable rivulets to storage ponds where children learned to swim and fish.

For generations, the suntanned sons and daughters of the Valley of God's Palm and the village of Chaparral rode their horses over the grassy foothill slopes. In the spring they rode through the gentle fragrances of flower-dotted fields; in the autumn, when grasses turned to golden hues beneath an ardent sun, they inhaled the heavy aromatic airs of that season. Wildlife swarmed in the fields and along the edges of the brush.

Between swimming parties, hunting, fishing, and riding, the young people of Chaparral also played tennis and many became world champions. Their beauty, health, and athletic competence attracted visitors as unfailingly as did their nostalgic stories of fertile acres, groves of golden oranges, water at the turn of a valve, and yet rainless days and eternal sunshine. The result of this publicity was a growing stream of new residents. The fragrant citrus groves around the town fell before waves of new homes and businesses. Strings of new homes crept outward and upward along every canyon and stream into the realm of the chaparral, the dense thickets of chaparro, or dwarf evergreen oak.

As the fame of the town spread, the residences of downtown Chaparral, with their lawns and gardens, were replaced by hardware, grocery, paint, and glass stores, by barbershops, filling stations, garages, curio and knick-knack shops, and all the other needs of a semirural community. The golden sons and daughters from the vanishing farms served the many needs of the new residents; but with indoor living, they were no longer golden and beautifully different. Nor did they win so many tennis matches. But few people in Chaparral noticed these changes because everyone was caught up with the ideas of progress and growth.

As taxes rose, the farmers sold out to land speculators. The drought- and fire-hardy chaparral vegetation throve on the neglected cattle ranches of the valley where, because of fire danger, natural fires were suppressed and controlled burning banned.

This brushy vegetation had come into being at the end of the rainy ice ages. Plant paleontologists knew of the chaparral's ancient existence in hot sunny climates, and called it a sclerophylous flora. Wherever climates are harsh and dry and fires are the main cleansing agents for disposal of fallen deadwood, the thick, resinous chaparral flourishes. Around Chaparral this "elfin forest," as the growth is aptly called in California, blanketed most of the lower hills and mountainsides and spread its interlacing mantle up into the forested mountain heights. Without fires, the clear areas in the pine forests became choked with thickets of spiny *Ceanothus*, chinquapin, and other shrubs, and the accumulating piles of fallen pine boughs. Nowhere were there the clear grassy glades among the tall boles of the forest that John Muir and other early explorers had reported.

The trees of the expanding elfin forest were useless for timber, and when they had matured up to their gnarled height of from ten to thirty feet they failed to furnish fodder for cattle or even for the native deer. Most lesser herbivores found the foliage either completely beyond reach, too sere and bitter, or too aromatic to eat.

Chaparral is an evolutionary adaptation to frequent lightning-set fires that ran unhindered through the brush until they succumbed in rain, adverse winds, or fuelless areas of recent burns. This process was aided by the advent of fire-using aboriginal man. Because wildlife fed avidly on the fresh, tender root crown shoots that appeared after a fire, they were easier to find and kill, and as a result, fire became more than a means to drive animals from thick cover: it became a calculated tool for concentrating large and small game.

The aborigines never bothered to douse these helpful flames. Under this utilitarian use of frequent fires the chaparral never became a continuous deadwood blanket. Fires traveling over the countryside were cooler and spottier than the ravaging killer conflagrations of today. The Spaniards, and later our own cattlemen, wisely followed much the same custom.

However, early in this century Theodore Roosevelt, our first politician-conservationist president, placed management of the national forests under forester Gifford Pinchot. Under Pinchot's direction, we adopted European forest management, even though conditions in Europe were often very different. Land management in most of the Old World included a peasantry that gleaned every fallen twig and cone for fuel, thereby keeping the forest floors clean.

With little realization of America's highly varied climates and ecology, fire suppression was universally applied in all national forest lands, whether timber or chaparral. One reason given for suppressing fire in the vast and noncommercial chaparral was the danger to the forests above. It was further alleged (without proof) that fire suppression was necessary for water conservation and flood control.

Thus, in the timber and elfin forests of California, including the slopes above the town of Chaparral, where for thousands of years frequent fires had shaped and maintained a special environment for plants and animals, fire was more and more effectively suppressed. The eloquent writings of antifire propagandists, the sentimental assertions of uninformed esthetes, the pleas for the prevention of cruelty to wild animals were combined in an antifire campaign undertaken by the U.S. Forest Service, assisted by Madison Avenue, and symbolized by Smokey Bear. Fire-fighting forces grew more effective, more extensive, and more bureaucratic. All opposition was smothered as effectively as the fires.

As fire-fighting methods and machinery were improved, more dry wood accumulated under the trees, the chaparral grew taller, and the forest glades became more cluttered with debris and brush. The thirsty chaparral dried the watershed streams and flowing springs. Canyons became increasingly choked with trash. From the mountaintops down to the lowest limits of chaparral, flammable debris was accumulating in a deadly fire trap, one that could lead to the fastest and deadliest conflagration of all—the crown fire.

Fire protection and suppression had to, perforce, become more in-

To do many different jobs NASA chose many different cameras. Hasselblad.

500 C

In 1962 NASA chose Hasselblad to be used by the Astronauts on manned spaceflights.

The first Hasselblad to go up was the 500C, aboard the Mercury Spacecraft Sigma 7. The camera has an 80mm Zeiss Planar f2.8 lens and 12-exposure magazine. All components are interchangeable.

The famous first walk in space by Astronaut Edward White, aboard Gemini 4, was recorded by Command Pilot James McDivitt, using a 500C.

NASA chose Hasselblad for the space program because of its legendary reliability, quality of results, ease of operation (Astronauts are not professional photographers) and scope as a photographic system. These same characteristics have made Hasselblad the choice of discriminating photographers on earth.

A Hasselblad camera is what you make of it. Snap on a super wide angle Zeiss Distagon 40mm lens, a 24-exposure magazine and an eye-level prism finder, and it becomes one thing. Switch to a Zeiss Tele-Tessar 500mm lens, a 70-exposure magazine, a pistol grip—and it becomes something else again.

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500 C/M

Super Wide C

For four years and eight manned spaceflights, the 500C was *the* Hasselblad space camera.

Then in 1966, a second Hasselblad was added. The wide angle Hasselblad SWC, with its 38mm Zeiss Biogon lens.

It made its first flight aboard Gemini 9, where Astronaut Eugene Cernan used it on his 2 hour space walk. During that walk the camera operated flawlessly in total vacuum.

An exciting glimpse of life inside the capsule was also made possible by the SWC, because of its sweeping 90-degree angle of view and great depth of field.

On earth the SWC is used by industrial, architectural, landscape and amateur photographers. The SWC allows them to work indoors and out, at extremely close quarters, with extraordinary sharpness from corner to corner and incredible depth of field (from 26 inches to infinity at f22).

News and sports photographers make interesting use of the unique features of the SWC by presetting it, snapping on 70-exposure film magazine, then using it to take grab shots when there isn't time to focus.

The versatility of the SWC is extended by the use of interchangeable film magazines and other components of the Hasselblad System.

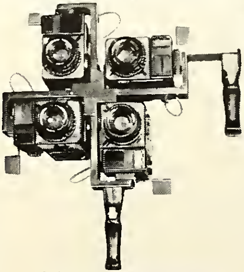
Super Wide C

500 EL

Two and a half years later, in December 1968, a third Hasselblad joined the space program—the electrically-driven 500EL. The event was the flight of Apollo 8. Two 500ELs went along—one with an 80mm lens, the other with a Zeiss Sonnar 250mm lens—plus 7 interchangeable 70mm magazines.

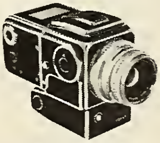
This was the first time that men journeyed from earth to orbit another world. The photographs from this voyage were essential in planning the forthcoming lunar landing.

The Hasselblad 500EL allowed more photographs to be taken with less effort, because no film winding was necessary. After each exposure the 500EL automatically readies itself for the next shot by advancing the film and cocking the shutter.

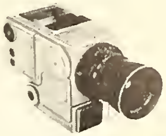


A 4-camera cluster of 500ELs used for scientific photography in space

This Hasselblad is the only electrically-driven 2¼″ camera on earth. Because of its automatic features, it can be successfully operated from a distance, freeing the photographer from the camera and allowing him to work more with his subject. That's part of the reason why the Hasselblad 500EL/M has won the esteem of advertising and publicity photographers, as well as sports, wildlife, industrial and scientific photographers.



500 EL/M



500 EL Data Camera

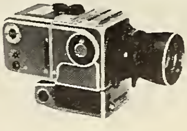
But the first camera to be used on the moon wasn't the Hasselblad 500C, or the SWC, or even the 500EL. It was a fourth Hasselblad—the 500EL Data Camera, with Reseau plate and Zeiss Biogon 60mm f5.6 lens. A photogrammetric camera, whose tiny cross-shaped index marks appear on the negative, making it possible to measure distances and heights with great accuracy.

When Astronaut Neil Armstrong took man's first walk on the moon, on July 20, 1969, the Hasselblad 500EL Data Camera was there with him, attached to his chestpack.

The 500EL Data Camera proved so valuable that an earth version—the MK70—was developed and is the newest addition to the System.

The MK70 fills a need for a small, easy-to-handle photogrammetric camera capable of producing exceptional results. The MK70 is the ideal photographic tool for use in applied engineering and construction work, as well as for mapping, architectural, industrial and medical photography.

For a free copy of the 48-page Hasselblad catalog, describing all the different cameras and accessories of the Hasselblad System, write Paillard Incorporated, 1900 Lower Road, Linden, N. J. 07036. Other products: Bolex movie equipment, Hermes typewriters and figuring machines.



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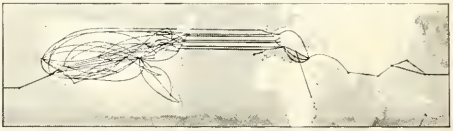

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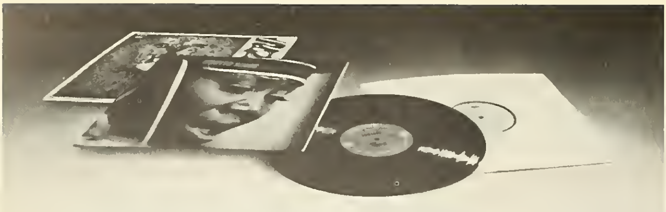

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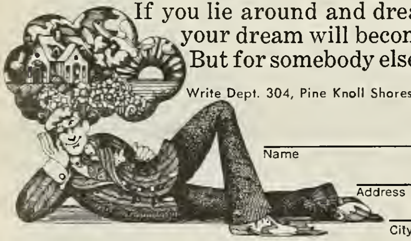

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tense and expensive. The propaganda from those responsible for this war against fire waxed in fury, and Smokey Bear gained ever more influence. With every fire, firefighting machinery, tactics, and over-all strategies multiplied and flourished. No fire routed Smokey Bear and his friends from their entrenched antifire position.

The engendered fear of fire allowed the chaparral to invade not only the forests, farms, and mountainsides but also permitted it to encroach downward toward the unbroken rows of houses in the town. No wonder every distant sign of wood smoke or even its faint odor on the winds brought fear.

Revealingly, almost every fire that escaped into the brush became a potentially uncontrollable wildfire. These hot, swift, and devastating fires swept through the pine forest, even forests of firs and giant sequoias, killing trees that had survived thousands of years of frequent fires. The forests and their wildlife, which had flourished without fire protection for millennia, were now under the intensive care of the Forest Service and Smokey Bear. Under such conditions, a single fire could and often did kill hundreds and thousands of animals. The fire-careless Indians and Spaniards had never caused such destruction.

In the flash-flood-ridden mountain areas and the vulnerable lowland developments, the antifire forces seized on yet another argument to support their position: the danger and cost of floods to homes, businesses, and even bridges, highways, and some dams. Since the imminence of damaging floods was inarguable, the propagandists for bigger fire-protective forces stressed this effective argument. Their appeals would never admit that the greater intensity of the fires, when they inevitably came, was related to the intensity of the floods that usually followed. When a watershed eventually lost all of its vegetative cover, the accumulation of exposed soil, charcoal, and ash—beaten to a froth by pelting rain—gathered in sheets and rivulets and streams, which rushed and roared down the cluttered watercourses to strike all at once with irresistible power, instead of little by little every year, as had occurred for past millennia.

Where once water had seeped into the water table and small increments of soil had settled in the valley, now water and nutriments rushed out to sea.

The people of Chaparral, whose board and batten homes crowded up to, and even into, the chaparral and the beautiful higher wooded canyons, became more apprehensive, more concerned that fire would in due time escape even trained fire fighters. Even multiplying helicopters, tanker planes, bulldozers, scrapers, pumpers, brave parachutists, and "hot-shot" fire crews were not infallible. Here was a design for an ultimate disaster, and nerves became frayed during the dry season—and that was many months of the year. The residents of the town became increasingly conscious of the looming menace that swept in on the winds of the Santa Ana, the hot breath of Satan's wife.

Among the townsfolk were some who became obsessed by the danger, and among them, by curious coincidence, was one Jonathan Behr, "an easterner," thoroughly and capably trained in the New England tradition of fighting forest fires. He was also shrewd, ambitious, and a born leader. Given his background and training, it was inevitable that he was elected the town's first fire marshall in 1953, and given full power to coordinate and build its defenses. Also inevitably, he was a complete convert to the policy of Smokey Bear.

The grave danger, the warnings of Smokey Bear not to let flame or spark touch flammables, and the fire marshall's obsession, amplified by his training and ambition, all led to an edict that no flammable waste was to be burned in fireplaces or incinerators. It was to be stored, in basements, garages, or other places out of reach of sparks or flame, until such time as trucks could cart it beyond danger. Not a fallen autumn leaf was to be burned. The old happy customs of Halloween, the pumpkins and bonfires, were banished.

Several dissident voices arose but they were only those of a few discredited individuals who long before had protested the Forest Service ban on all controlled burning. They were quickly silenced.

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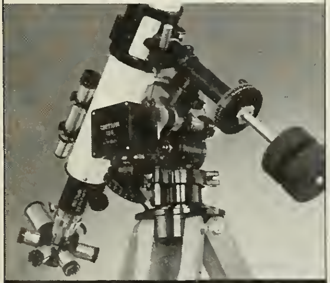

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crats, Jonathan Behr demanded and got an almost limitless string of additions to his fire stations, fire ordinances, fire communications network, and transport system—including helicopters and light fire-spotting planes. Each year a serious pileup of flammable waste built up in the town—but innumerable posters of Smokey and exhortations on television and radio supported what the trained authorities proclaimed as the proper way of preventing fires. As always happens, however, some citizens of the town were slipshod about housing their waste and stuffed it into any convenient out-of-sight hideaway.

Despite the numerous dangers, the antiburning doctrine was surprisingly successful. For a number of years there were no fires either in the town or in the mountains looming above it. There were, of course, frequent reports of distant fires. The residents of the town followed these reports intently on television, radio, and in the daily press. The net result was an even more fervent determination to let nothing start a fire anywhere. Too many simultaneous fires, even far distant ones, might overtax all of the state's fire-fighting forces. So Chaparral resolved to conduct its own battle in the event of a fire, and Fire Marshall Behr's responsibilities, fire-fighting apparatus—and salary—grew accordingly.

But one superheated September day, while Marshall Behr was off enjoying his annual deer hunt, the violent, parched Santa Ana blew across the Valley of God's Palm. Far above the town, from his favorite aerie where he could look fondly down on his town, Behr was, after taking all due precautions, lighting his cooking fire in the safety stove supplied by the Forest Service. As he applied his fifth match to the green kindling he had mistakenly gathered, the flame burned his fingers. He jerked his hand back and accidentally tossed the still-burning match behind him. In the moments it took him to realize what he had done, a flame was already burning in the duff he had carefully scraped to one side. The fire spread so fast that he could not stamp out the flames or quench them with the water in his coffee pot and canteen. Fanned by the vanguard breezes of the dry wind, the fire was on its way, explosively igniting the mountainside blanket of sun-baked, resinous tinder.

This took place on Pine Mountain, where for 55 years fire suppression had been 100 percent effective and where for scores of miles the chaparral had grown tall in the forest and now extended, almost unbroken, down to the valley floor.

By the time the first scout plane reached the scene, the gusting winds were already hurling flaming forerunners far ahead of the main line of the fire. Here and there the woodland developed its own fire storms of little whirling dervish cyclones, laden with flaming leaves and branches. Main gusts caught these upflung torches and hurled them hundreds and thousands of feet, sometimes as much as a mile, ahead of the main fire.

In the blackness of the roaring night that followed, these advance guard fires showed first as fitful lights that waxed and waned and seemed like lonely, harmless will-o'-the-wisps in the vast darkness; then as harmless bonfires, before they, too, suddenly took off with a roar.

The painfully constructed and expensive firebreaks that ranged across the rough terrain were no hindrance to the raging, leapfrogging fire. Under different conditions the firebreaks should have served admirably for limiting carefully timed control burns, which could have provided an effective barrier to unplanned wildfires. But during the Santa Ana, only large areas devoid of fuel could check, let alone halt, a fire driven by the deadly combination of near zero humidity and superheated, fast-moving air.

By noon of the second day it was clear that only the advent of a low-pressure front, with a reversal of the winds, or fog or rain could save the town of Chaparral. But the intense blue sky was free of even premonitory cirrus clouds, the shade temperature rose to 108 degrees Fahrenheit, and the winds blew unremittingly.

Fortunately, Behr's foresight had included training in fire drills. As a result, the town was prepared for fast and orderly abandonment. Under the fire marshall's generalship, every unessential man, woman, and child, as well as most small pets, had escaped before a vagrant flam-

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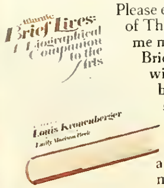
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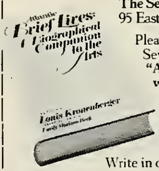

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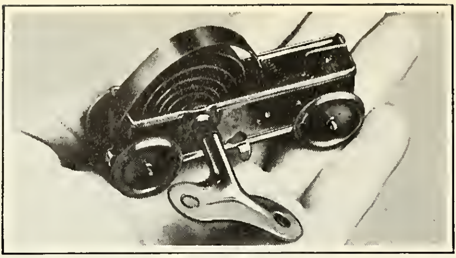

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ing brand fell into Behr's nephew's backyard, where a pile of loose excelsior and shredded paper had been temporarily concealed between a wooden fence and a garage. And this garage-workshop contained the usual accumulation of half-used tins of paint, thinners, solvents, still-soaking brushes, and other flammables. So the remaining fire fighters lost the last chance to save the town. They hastily retreated along the last open highway and joined their families some twenty miles away in the safety of nonflammable avocado and citrus groves nearer the sea.

Only the speed and reliability of modern transportation had enabled the entire town to be evacuated rapidly without a single casualty. Cars, campers, trailer trucks, large camp trailers, and even school buses carried every person, young or old, ill or well, to safety. The last reluctant refugees, the fire marshall and his professional assistants, paused at the summit of the highway pass and gazed back at the devastation from which they had escaped. The site of the lovely town of Chaparral was only a central focal point for rolling black clouds of smoke.

When the refugees dribbled back to their village, they found that not a single home, not a store, church, office building, or school had survived in usable or even repairable condition. Except for numerous, stinking black clouds from smoldering basement-stored papers and waste, the fire had ended. So had the town.

Since that tragic event a decade ago, the townsfolk have been replanning and reconstructing Chaparral. Interestingly, the first town meeting was devoted to the formulation of realistic ordinances regarding fire prevention. All highly flammable trash was to be burned each day in well-screened and guarded incinerators. Instead of purchasing more fire-fighting equipment to meet hazardous conditions, a fleet of rubbish-collecting trucks is now solving the problem at one-tenth the expense.

Possibly the best long-time benefit of the calamitous lesson has been the mounting scorn for the folly represented by the pictures and wood carvings of Smokey Bear, the totemic emblem selected by the Forest Service. If the townspeople

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But frankly, we still need your help. So without any further ado, we would now ask you to continue in the battle to keep alive and free, the heritage of East African wildlife that belongs to everyone-especially you. What a pity it would be should your child's next question be "What WAS . . ." rather than "What IS a Cheetah?" But that could be the case with cats and other species if the numerous activities of the East African Wild Life Society have to be curtailed for lack of funds. Cheetah, lion, leopard and other animals of the region if not protected, may take their place in the history books, alongside the Dodo, just as dead, just as extinct.

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had listened to the bitter comments of some of their dispossessed citizens, the disaster would have been commemorated in the town's central square by a gigantic statue of Smokey Bear and Johnny Behr, arms linked and faces wreathed in smiles of mutual admiration, surmounted by a perpetual flame.

The citizens of Chaparral now lead the state in demanding that the national forests be protected from senseless damage. They advocate two different administrations: one to continue research on the varied roles of natural and controlled burning; the other to promote the concept of multiple use without abuse. They realize that until far more has been learned, the least management is the best management. Their goal is to simulate the operations of nature that created the elfin, sequoian, and pine forests in the first place. They also foster the preservation of numerous untouchable and unmanaged wilderness sanctuaries.

Long-term research in the benign use of fire, probably century-long experimentation and observation, will be indispensable to the discovery of the ancient forces that created our forests. Lightning-set fires undoubtedly established the basic pattern but for some ten millennia or more the Amerinds, and then later the Spaniards, had added to lightning as a fire-causing agency. Surely modern man can do an equally meritorious job with fire and save us from holocaust once we have been emancipated from irrational fears.

Already the hillsides around Chaparral are responding favorably to even the crudely applied control burning that is now permitted. Beautiful grasses and forbs have reduced the sheet erosion and gully-cutting floods that only a few years ago were so destructive.

Without the ravenously thirsty, deep-rooted chaparral to suck out moisture left by the winter rains, springs are again common, and long-dry streamlets have resumed their flow.

The valley and its town have almost returned to their pristine state of an earthly paradise. Spring flowers clothe the hillsides. Chaparral's sons and daughters play in the sunshine; once again they are golden brown and joyous. ■

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Letters

Battle of the Sexes

"From Mother Goddess to Dishwasher" [February, 1973] is a splendid and basic document for women's liberation—and gives that current counterculture a sobering idea of what there is to counter.

I have noted, as author Dena Justin has, the comparative suddenness of the male revolt. It seems to have happened when the female monopoly of agriculture began to give way to the development of animal domestication, predominantly by males. In the breeding of animals, unlike the tending of plants, you soon discover that a female herd is not a fountain of fertility without some male assistance. That discovery seems to have intoxicated the human male, rent the veil of the Great Mother's mystery, and revolutionized human society. I personally think the boys overreacted.

L. S. Engel
Bloomington, Indiana

My wife called my attention to Dena Justin's article. I pointed out to her that Justin's analysis is fine as far as it goes, but that it omits an important phase of social evolution.

The whole Great Mother Goddess problem is the fault of the women who, according to Justin, invented agriculture. By so doing, they tied the community to a specific territory. That led to aggression by other tribes, who preferred taking over already cleared land to doing the work of clearing their own. Men were of less social value than women and also bigger, so the women egged the men on to do the aggressing. To get the men to go raiding, women had to pat them on the head and tell them what fine, handsome brutes they were, thereby inventing the ooh-and-aah technique, since refined to an art.

Once women had committed themselves to the proposition that men were handsome, smart, and useful, they had no way to back out. So that's the way it went. And, as a matter of fact, that's the way it's still going.

Col. Frank B. Case
Alexandria, Virginia

Research

Dr. Strehler's article, "A New Age for Aging" [February, 1973] was interesting and informative, but I would like to take issue with him on one point. Technological crash programs on problems with rigorous bases, such as the Manhattan Project and the NASA space effort, have proved successful. However, this does not guarantee success for similar methods applied to problems as immensely complex and as theoretically poorly understood as, for example, cancer, or in the case of Dr. Strehler's field of interest, aging. Spending more money is not the complete answer to solving the problem of aging, nor is an organized effort such as a National Institute for Research on Aging.

What is most important is to attract outstanding scientists to the effort. Dr. Strehler himself admits that scientists sitting on review panels are "underinformed" about aging research. This, perhaps, reflects the status of aging research in the scientific community.

As the history of science shows, breakthroughs in science most often are the results of individual efforts by exceptional scientists and are not necessarily proportional to total expenditures of scientific energies.

J. P. Segrest, M.D., Ph.D.
National Institute of Arthritis,
Metabolism and
Digestive Diseases

Jumbo Error

I enjoyed Harvey A. Ardman's article on Jumbo [February, 1973]. However, I don't agree with his statement that the engineer of the train that struck the elephant was killed. It has long been a family tradition that my wife's great-grandfather, John Taylor, was the engineer of the locomotive that killed Jumbo. His grandson, Andrew R. Taylor, is my father-in-law. Andrew R. Taylor is still hale and hardy at 83 and remembers John Taylor and the history of the accident. About the only moral that can be drawn from the story is that one should not exercise one's elephant on a railroad track.

Charles L. Horn, Jr.
Minneapolis, Minnesota

Bamboo Curtain of the Mind

In your February "Letters," Charles Chandler charges columnist Arthur Galston with leaving "his critical faculties at home" when he made his trip to China. Mr. Chandler's sharp comment sent me back to the October and November reports to discover the flaws he had found. Even after careful examination, I couldn't find them. The reports are almost entirely descriptive. There is nothing in them that contradicts the recent observations of others, including Richard M. Nixon and Joseph Alsop, both of whom have a long history of anti-China bias.

Has Mr. Chandler simply closed his mind to the idea that anything good might have grown out of Red China?

J. H. Elder
Pullman, Washington

The Fisher and the Forest Service

"Return of the Fisher" [January, 1973] neglected to mention one important factor. The entire Ottawa National Forest contains an unnaturally high number of artificially

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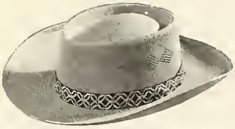

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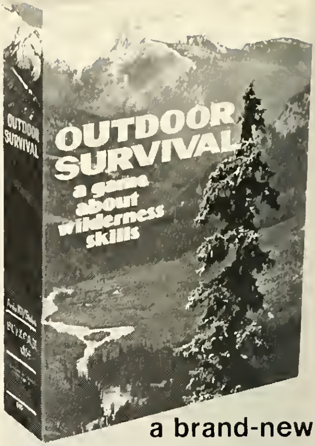
propagated pines and other mature trees. This is largely the result of complete protection from fire and a level of logging that allows extensive tracts to grow to a static climax.

The porcupine, damaging mainly older hardwoods and maturing pines, is a natural agent for maintaining the youth and variety of the forest by destroying older trees and letting in sunlight, so that younger ones may grow. Since the economic value of pine and older timber is the motivating factor in managing most national forests—to the detriment of wildlife dependent upon a more youthful, balanced forest habitat—the porcupine is a villain according to the U.S. Forest Service.

This unbalanced timber management program is largely responsible for the vast decline in white-tailed deer in the western districts of Upper Michigan and for the slow retrenchment of those species that are dependent on similar habitats—ruffed and spruce grouse in particular. A booming porcupine population could slow up the closing in of the forest canopy. The slaughter of porcupines as a form of vermin has always been a sore point with those who prefer natural to economic values for public lands.

The reintroduction of the fisher is a desired re-establishment of a once native species, adding variety to the increasingly simplified fauna of the Lakes States. No one quarrels with the introduction of a native species that has declined or vanished. Many of us, however, disagree with the underlying assumption that the national forest is a huge tree farm. The idea that any creature that impedes the economic success of the grand silvicultural design must be reduced or eliminated is abhorrent. As the Forest Service becomes more sensitive to the meaning of "multiple use," this tree farm mentality is, to be sure, slowly being counterbalanced. The porcupine control program and the perpetuation of overmature forests are not things to be taken as gospel, but are highly debatable management priorities that are not directly related to the ennobling idea of a self-sufficient, balanced natural community.

David Backus
Land O' Lakes, Wisconsin



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by Arthur W. Galston

China's Far-flung Children

Despite political differences, Chinese expatriates take pride in the new stature of their mother country

Have you ever heard of the Tiao-Yu-Tais? I had never even encountered the words until I returned from China in May of 1971; I didn't know whether they referred to a people or a place. As the first American scientist (together with Ethan Signer, a molecular biologist from the Massachusetts Institute of Technology) to have visited the People's Republic of China since its founding in 1949, I understandably received a flood of requests to speak to a wide variety of groups about my impressions of life there.

One of the first invitations came from a group of students at Columbia University representing themselves as the Committee to Defend the Tiao-Yu-Tais. The students were all, they said, ethnic Chinese who had developed a great interest in the new China. They were relatively few in number, but high in interest. Their eagerness persuaded me, and after some juggling of my schedule, I agreed to talk to them. I assumed from the description of their group that it would be a small, rather intimate session. This interested me, especially because I had not yet had an opportunity to probe the thinking of expatriate Chinese about the new China, or to explore their reactions to the generally favorable things I had to report.

Imagine my consternation when I arrived at Columbia and found an audience of at least 700, with some reports placing it as high as 1,000! Not only were members of the university community present, but also an astounding number of non-university Chinese. The organizers had advertised the meeting throughout Manhattan's Chinatown, and many of the area's residents had come. I honestly did not know what to expect, but I half anticipated an antagonistic reception because many Chinese now resident in America had fled the mainland immediately after the Communists came to power, or had come to the United States from Taiwan sometime thereafter. I did not expect either group to have many positive thoughts about the kind of society built by Chairman Mao and his disciples.

Following a few introductory remarks about the organization of Chinese society and a few details about the generally healthy and happy appearance of the people in both city and countryside, I launched into a fairly lengthy slide show. I started with Canton, where our trip had been organized and where the International Trade Fair had been in progress for some weeks when we arrived. One of my first pictures was a scene in the fair's Hall of Agriculture, dominated by a huge mural depicting Chairman Mao surrounded by a group of happy, triumphant-looking peasants in a field heavy with golden wheat ready for harvest.

Suddenly the hall reverberated with applause. I looked around, surprised. It was mainly the Chinese who were applauding; some of the more enthusiastic listeners were on their feet, excitedly pounding their hands together. They were obviously applauding Mao. I was later to learn that despite their political differences with the Communists, many Chinese in this country are terribly proud of China's new strength, dignity, and stature in the community of nations. It was this feeling that had brought them to spirited applause.

After the lecture several of my hosts chatted with me about the things I had described. It was then that I asked about the Tiao-Yu-Tais. What were they? Why was there a committee to defend them? What did all this have to do with the question of China in the world today?

By way of answer, one of the students unfurled a rolled-up map and pointed to an area in the East China Sea. There he singled out a tiny group of islands, which the Chinese call the Tiao-Yu-Tais; the Japanese, the Senkakus. These islands, lying between Taiwan and the Ryukyus, which run northward to the Japanese homeland, were scheduled to be included in the Okinawa reversion treaty (which became effective on May 15, 1972). Under the terms of the treaty, the United States agreed to relinquish its administrative control of the Ryukyus, held since the bloody military victory of 1945, and return the islands to the Japanese. It is clear, both from the map and from a cursory reading of the history of the region, that the true ownership of these islands is very much in doubt and that a case can be made for either Chinese or Japanese sovereignty. But why get so excited about a few specks of land in the middle of the ocean?

The answers surprised me. First, there was the great matter of principle. Land that belongs to China should not be given away to any other country; every square inch is precious to the Chinese people.

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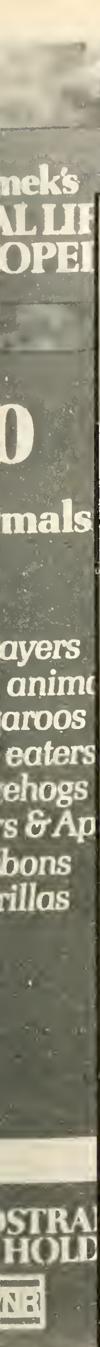

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We take this opportunity to thank the staff of Natural History and all of our friends/customers who have helped us recover from the disastrous floods of 1972. At the risk of sounding maudlin: We love you all.

Whatever their political persuasion, these expatriates believe in the integrity of China and in the necessity of defending it against dismemberment. They are still rankled by memory of the cession of large blocks of valuable territory to both the Russians and the Japanese during the nineteenth century when China was weak, and these Chinese students do not wish to have the process continue.

Equally important, recent geologic explorations had revealed the presence of potentially major oil deposits near the islands, which, like Taiwan, sit on the continental shelf. In the students' view, awarding these islands to the Japanese would preserve these rich resources for exploitation by a joint consortium in the capitalist world and prevent their falling into the hands of the Communist Chinese, who, they believe, must ultimately exert sovereignty over Taiwan and its adjacent islands.

How is this conflict to be resolved? At the moment, the Japanese do have quasi-legal sovereignty over the disputed islands because the United States has specifically included them in the reversion treaty. But were they "ours" to give in the first place? The Chinese say no on historical grounds, adducing geologic evidence as well to back up their claim. Recent submarine exploration has revealed a deep oceanic trench separating Taiwan and the Tiao-Yu-Tais from the rest of the island chain. Thus, they are a part of the land mass that includes mainland China, not of the volcanic islands that make up Japan.

When I was preparing to return to China in the summer of 1972, I was contacted by New Haven members of the Committee to Defend the Tiao-Yu-Tais. They wanted to know if I would carry a message from their organization to Dr. Kuo Mo-jo, the venerable head of the Academy of Sciences of China. I agreed to do so, and once I was in China transmitted their document, along with some other papers, to Kuo via courier. I received no immediate reply, but just before we left China we were invited to the Great Hall of the People to meet with Kuo, his wife, and several other officials in the fields of education and science. Kuo expressed his great joy at having received the message I had brought him and asked whether I would carry back his reply. Here it is, a rather remarkable document from an incredibly resilient and resourceful scholar - playwright - archeologist - doctor. It may tell us much about the appeal of modern China for its scattered expatriates.

Comrades of the Action Committee to Defend the Tiao-Yu-Tai Islands:

I have received your letter, which Professor Galston brought to me. I wish to express my thanks for your kind regards.

Since the Paleolithic age, Taiwan has been inseparable from the Chinese mainland. The archeological discoveries of stone axes and three-leg pottery are of the same type as have been found in Fukien province. You were born and brought up in Taiwan or Hong Kong but, of course, you are children of China. The motherland will not forget you, never. She is always waiting for you, she is always ready to embrace you.

The movement to defend the Tiao-Yu-Tai islands shows your patriotism. The Tiao-Yu-Tai islands are part of Taiwan and Taiwan is a province of China. Any attempt to separate them is doomed to failure.

Japan is now at a crossroad. Whether to be a militaristic or a peace-loving country is a question that reflects the difference between the Japanese ruling class and the Japanese people. The reactionary Japanese ruling class, whose minds are muddled by the benefits of rich oil deposits on the continental shelf, try to take our islands, the Tiao-Yu-Tai. Our government has made it very clear that China is not the China of thirty or forty years ago. We will not allow even an inch of our land to be taken away. The Japanese reactionaries, if they do not acknowledge their mistake, will only raise a stone and drop it on their own feet.

The new China is only twenty-two years old. Our progress may not be satisfactory in every phase, but our road is in the right direction. I believe that if we follow this road and work hard, twenty or thirty years from now everything will be even more beautiful and bright.

Let us work hard.
Salute.

Kuo Mo-jo

Columnist Arthur W. Galston teaches biology at Yale University.

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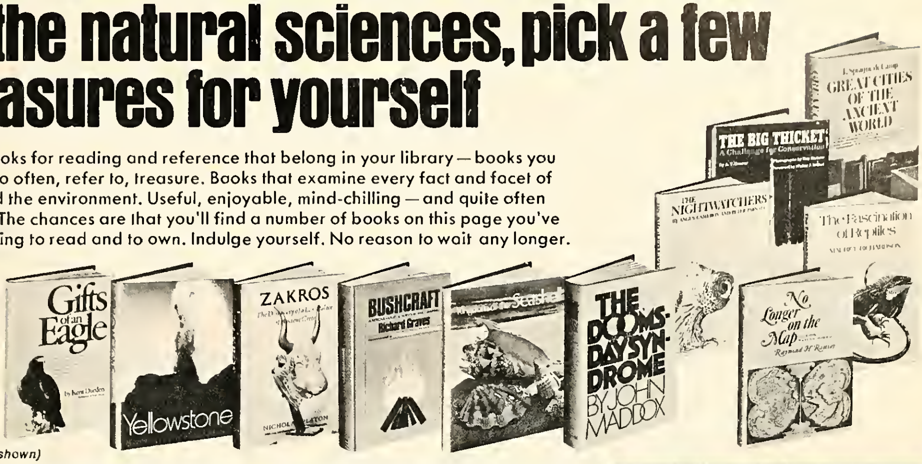
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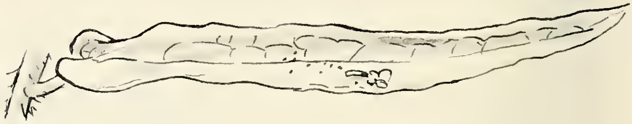
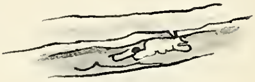
Metamorphosis of the Monarch

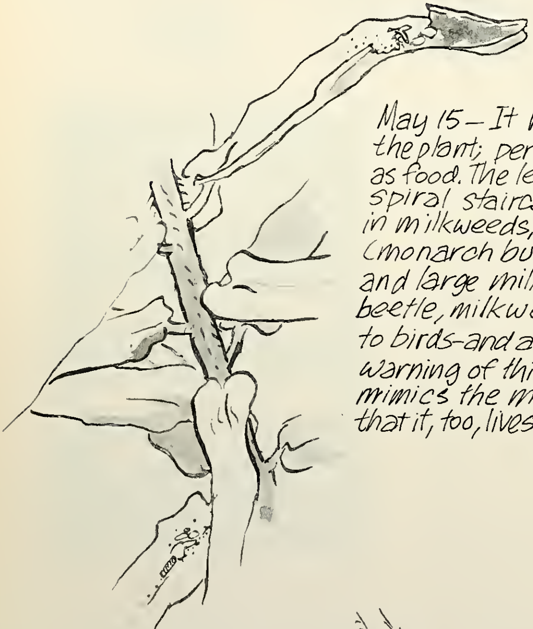
Jecon Gregory

So fragile is the development of this insect from caterpillar to butterfly that a breath of wind, a misplaced footstep, or a hungry wasp can instantly end its graceful future

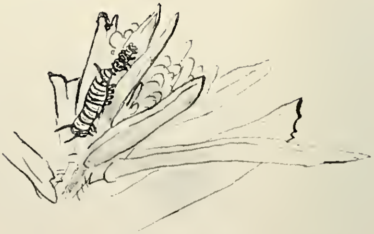
May 14—
A monarch caterpillar hatched today on a leaf of a butterflyweed—a kind of milkweed.

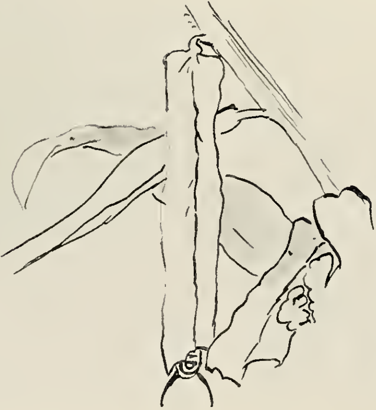






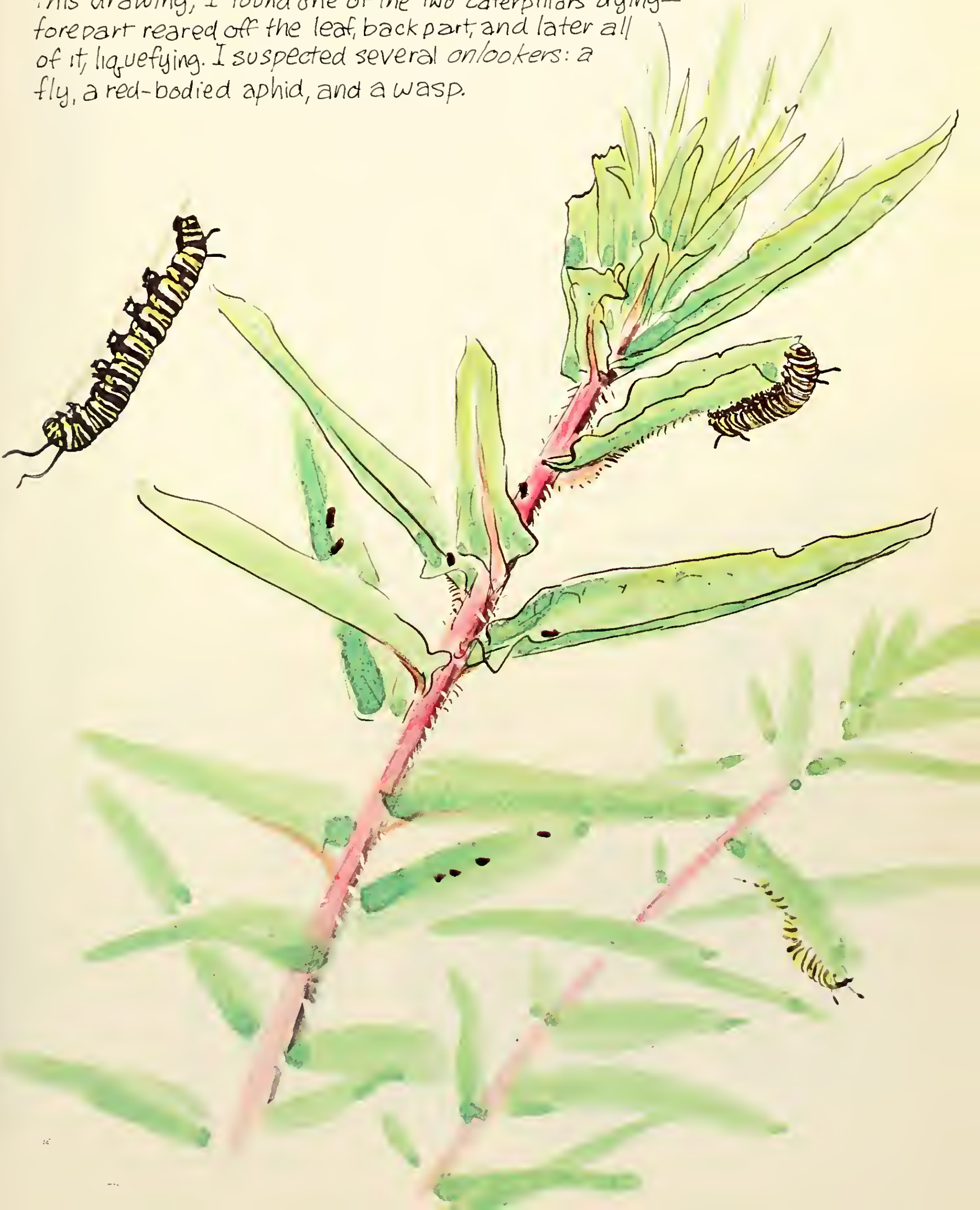
May 15—It has moved nine leaves down the plant; perhaps needs exercise as well as food. The leaves are quite like a spiral staircase. Because of the acrid juices in milkweeds, insects that feed on them (monarch butterfly, queen butterfly, small and large milkweed bug, four-eyed milkweed beetle, milkweed leaf beetle) are distasteful to birds-and all have orange color as a warning of this fact. The viceroy butterfly mimics the monarch's appearance to pretend that it, too, lives on milkweed.



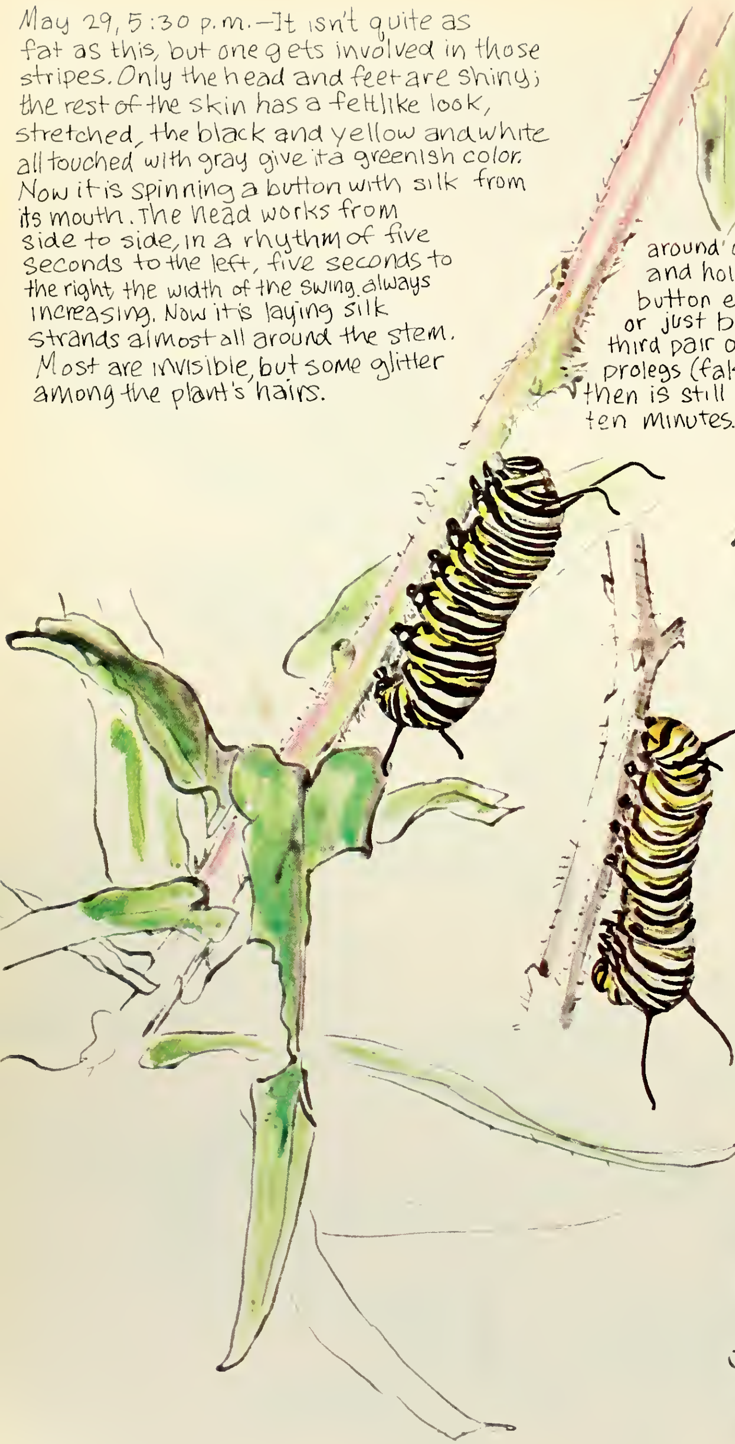


May 24—Ignored the caterpillar for a time, then remembered to look, but at first couldn't see it. Suddenly there was its head, past the chewed end of a leaf it was weighing down. This impressed me with how much it has grown—nearly an inch long. Yellow stripes are now well marked, and pairs of whiplashes have appeared at either end of the body.

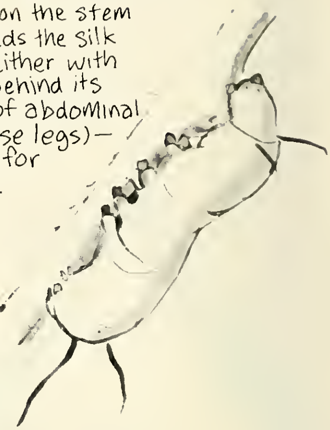
May 29 — At first there were five in the family, each with a stem of the milkweed to itself. Some predator got all except two. I made a chicken wire cage to go over the plant, but the predator, of course, was not a bird, and half an hour after making this drawing, I found one of the two caterpillars dying— forepart reared off the leaf, back part, and later all of it, liquefying. I suspected several *onlookers*: a fly, a red-bodied aphid, and a wasp.



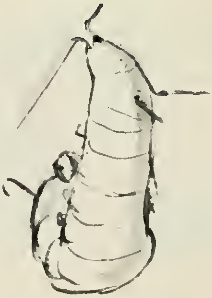
May 29, 5:30 p.m.—It isn't quite as fat as this, but one gets involved in those stripes. Only the head and feet are shiny; the rest of the skin has a feltlike look, stretched, the black and yellow and white all touched with gray give it a greenish color. Now it is spinning a button with silk from its mouth. The head works from side to side, in a rhythm of five seconds to the left, five seconds to the right, the width of the swing always increasing. Now it is laying silk strands almost all around the stem. Most are invisible, but some glitter among the plant's hairs.

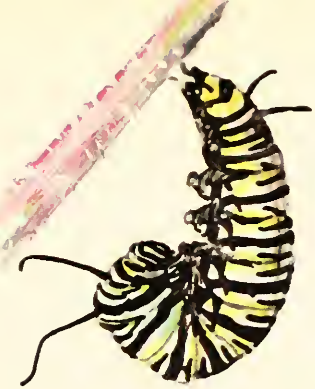


6:45 p.m.—
It turns around on the stem and holds the silk button either with or just behind its third pair of abdominal prolegs (false legs)—then is still for ten minutes.

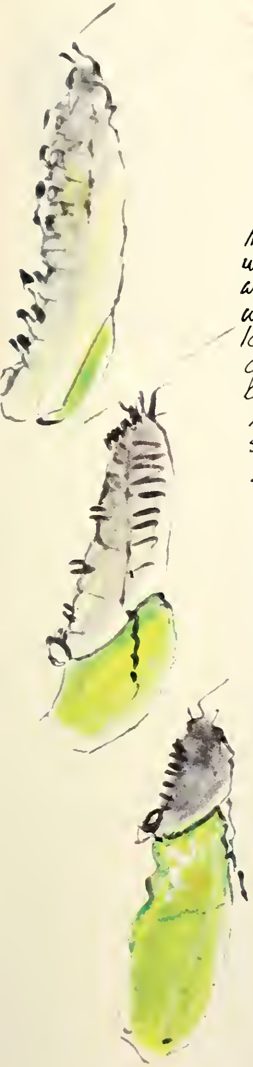


7:00 p.m.—Now it occasionally shifts the rear of its body while firming its grip on the button. The front legs touch the edge of a leaf; sometimes they let go altogether. The yellow and white parts of the front of the body as far back as the third pair of true legs are taking on a greenish cast.





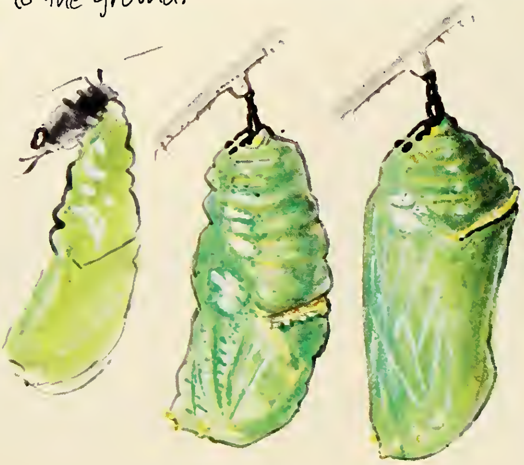
It hangs from the button and varies the curl, apparently hoping to raise its head, but because of the stem's sharp angle, it cannot assume a J shape until I push the stem downward. Thus I leave it at 10:00 p.m.



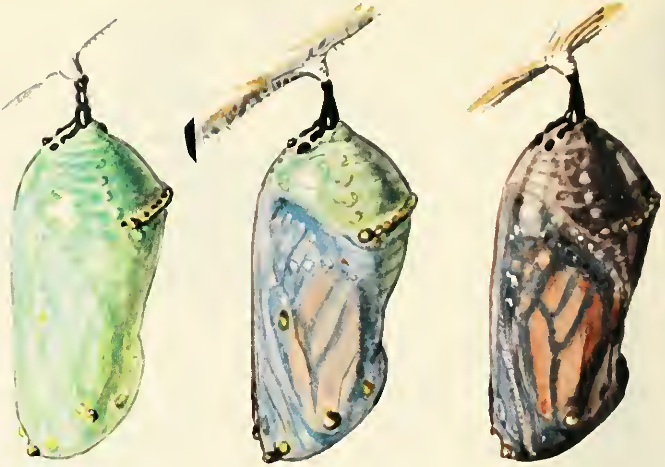
May 30 – I arose several times in the night lest it pupate without me. Now at 7:30 a.m. I am waiting. I notice that what were white spots on the sides of the false legs have become windows – the skin is transparent, revealing that there is no longer any flesh inside. Then I notice that the whole end of the abdomen, too, is empty, except for the black portion by which it clings to the silk button.

At 8:00 am. it starts moving – head bobbing in and out of shoulders. Actually, the head is stationary, and the body shrugs up to it, four times a second. The front whiplashes twist and untwist three times. I now see that the yellow marks showing through the skin will be the knobs and ledges of the future chrysalis.

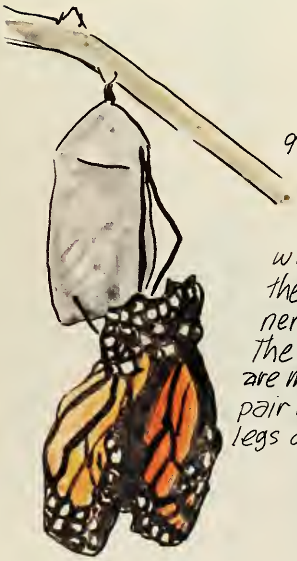
Suddenly at 9:50 a.m. the skin starts to split from behind the shoulders. I have to sketch fast. At the same time I see that the false legs have shrunk, the true legs are farther apart, and all are riding upward. The green pupal body looks wet, but this may be just the sheen of newness. It straightens, wriggles, forcing the skin to the body's narrow end. Empty headpiece, empty legpieces, and withered whiplashes gather in a gray scrap, which falls to the ground.



At 10:20 a.m. The chrysalis has not yet formed. Swinging intermittently, it continues to sort its organs till at 11:30 it achieves the shape, "the green house with golden nails." (Surprising that no one has made jade chrysalis earrings.)



May 31 – The green is on its way toward turquoise, the structures under the glassy coating are on their way toward clarity – it will be a week and a half until the flowering into a butterfly. When I first look at the chrysalis in the dark of each morning, all I see is a mysterious pinhole of light – it is the small mirror of one of the knobs facing the source of light in the east. When the chrysalis is between me and the light, all but its upper dome is translucent. For it is now largely liquid within, as the components of the caterpillar rearrange themselves into the components of the butterfly. All this without the use of space beyond the strict, elegant boundary of the chrysalis; without as much as a shift of gravity, which would cause the chrysalis to swing.



June 8 – 8:00 a.m. – Another night of getting up in fear that the butterfly will emerge without me.

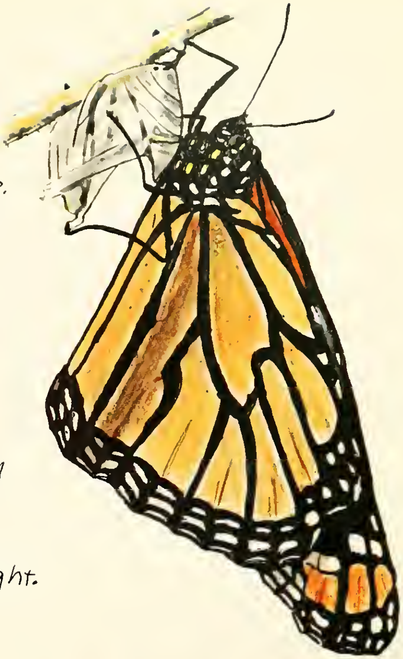
9:00 a.m. – The glass face of the chrysalis lifts out! The back splits and rolls up in three scrolls – a thing like a limp, struggling machine scrambles free. I have no time to draw the critical moments. At first the wings are pleated, which is why only about a third of the wing showed through the chrysalis wall. Slowly the nerves fill, the wings increase in area and dry. The feelers are at first laid over the back. The mouth parts are moving. There seems to be only four legs; the first pair is shrunken and hardly used. In gusts of wind the legs desperately shift their hold on skin and stem.

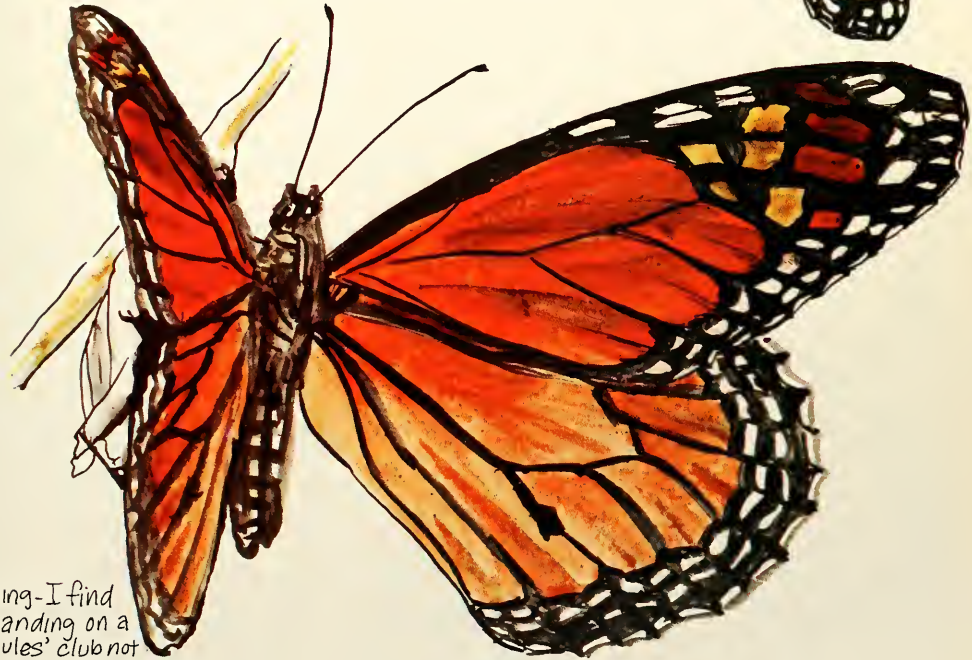
The abdomen, which in the chrysalis was like a telescope fully rammed in, elongates until it reaches the corner of the wings. Five times it excretes a large drop of pinkish-brown liquid. The black lines on the wings are rather wide, which shows that the butterfly is a female.

About 10:00 a.m., the first wing opening—

She unfolds herself twice—then after resting shut for a long time, she turns her head from side to side, opens her wings again for two or three quick strokes, then half a dozen more strokes at longer intervals.

11:00 a.m.—a wing opening no different from other wing openings launches her—first to an oleander, then 25 feet slightly upward to a palmetto. She can't get a footing, lands on a palmetto leaf—then away again and out of sight.





Evening-I find her landing on a Hercules' club not far away. I startle her and she moves again, to a chinaberry for the night. Next Morning, she is gone—starting the spring migration northward.

An Indian Journey to Life's Source

by Peter Furst

In their annual search for peyote, the Huichol of Mexico transform themselves into ancestral deities and follow the rituals of a pre-Columbian pilgrimage

---

And they knew the qualities, the essence of herbs. The so-called peyote was their discovery. These, when they ate peyote, esteemed it above wine or mushrooms. They assembled together somewhere in the desert, they sang all night, all day. And on the morrow, once more they assembled together. They wept; they wept exceedingly. They said their eyes were washed; thus they cleaned their eyes.

Fray Bernardino de Sahagún
General History of the Things of New Spain, Book 10

Father Bernardino de Sahagún, a sixteenth-century Spanish chronicler and the first scholarly ethnographer of Aztec civilization, credited the primitive desert hunters of northern Mexico with the discovery of the hallucinogenic cactus peyote (*Lophophora williamsii*). His descriptions of their peyote rituals could apply today to the modern Huichol. Each year small bands of these Indians still assemble in the desert, some 300 miles northeast of their homeland in the Sierra Madre of western Mexico for the traditional "hunt" for the peyote, which they equate with the divine Deer and which they esteem above any other psychotropic plant. Huichol religion, especially the peyote quest and its symbolism, appears to be the only survival on a major scale of relatively pure Indian belief and ceremony in Mexico today.

Not every one of the 10,000 Huichol-speaking Indians has participated in a peyote hunt; some have not even tasted peyote. But so integrated is the sacred cactus in Huichol culture that there has been no dilution of the traditional beliefs regarding peyote. Nor has there developed a tendency to substitute more readily available substances, despite the distance that separates the Huichol homeland from Wirikúta, the sacred peyote country in the north-central state of San Luis Potosí. On the contrary, the very duration, privations, and other difficulties of the peyote pilgrimage are themselves an integral part of the peyote quest.

It is a hunt in the literal sense, because to the Huichol, peyote and deer are synonymous. The first of the sacred plants to be seen by the leader of the hunting party is believed to contain the essence of Elder Brother Wawatsári, "master" of the deer species. This explains why peyote is first "shot" with a bow and arrow before being dug from the ground and divided among the participants in the hunt. At the same time, peyote embodies the sacred maize, so that deer, peyote, and maize together form a symbolic complex. As interpreted by Barbara G. Myerhoff in her forthcoming book on Huichol symbolism (*The Peyote Hunt*), these three elements become fused on the peyote hunt.

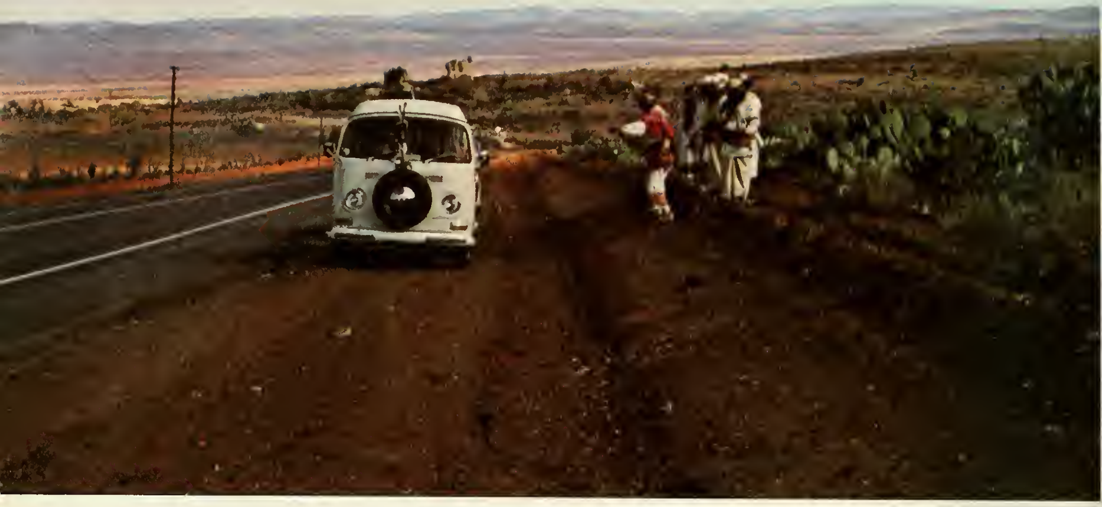
On the level of the individual participant, however, the pilgrimage also embodies elements of shamanic interaction, with its characteristic aspects of death and rebirth and the ecstatic trans-experience of peyote. Nevertheless, unity and the reaffirmation of the social, natural, and supernatural equilibrium are clearly of utmost importance. This is what the Huichol mean when they say that on the peyote hunt "we go to find our life."

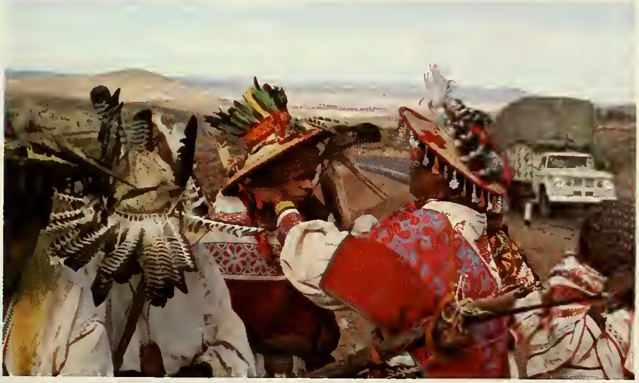
Peyote pilgrimages may take place at any time between the end of the rainy season, in October or November, and early spring. Both pilgrimages in which I took part were led by my friend and longtime informant, the late artist-shaman Ramón Medina Silva. It was on my second pilgrimage, in 1968—Ramón's fifth—that he became a full-fledged *mara'akáme*, the Huichol term for shaman, which also embodies some of the functions of a priest. As the Huichol would say, "He completed himself." For a man who would become a shaman must, among his other preparations, undertake at least five peyote hunts. He must accept the physical and psychological burden of leading and guarding his companions on this most sacred ritual enterprise, which each time re-enacts the first peyote pilgrimage of the gods; the pilgrims themselves take on the identities of their ancestral deities.

Nowadays, most pilgrims use whatever vehicles are available—

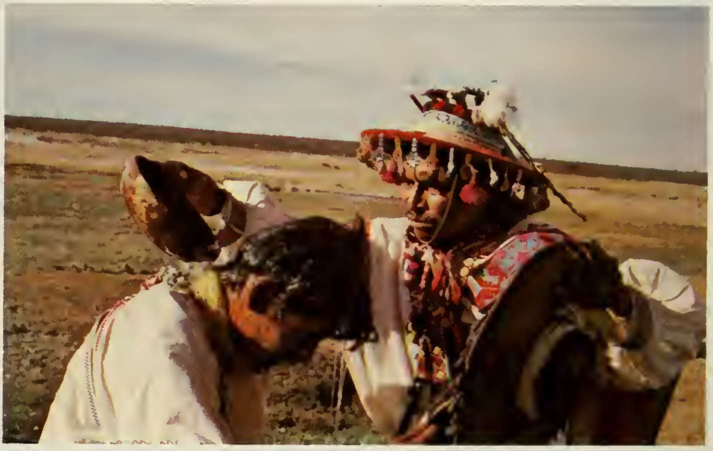
As Ramón leads the pilgrims into the peyote country, he makes music by beating his bowstring with an arrow. To obtain tonal variations, he presses his mouth against the bow.

PETER FURST





The foot pilgrimage begins, above, outside the central Mexican city of Zacatécas. Antlers over the spare tire of the bus that transported the Indians from their village represent a deer spirit. A blindfolding ceremony, left, symbolically returns novices to a pre-existent state. Below, a pilgrim is washed with chilly spring waters to enable him to better "see" the sacred country.



PETER FURST

cars, trucks, buses, wagons, even trains—to go to the peyote country. This is acceptable so long as all the sacred places along the way are properly acknowledged, with offerings left at the most important ones, and all ritual requirements attending the traditional journey fulfilled.

Generally, the quest follows an autumn ceremony in which children, the shamanic drum, new maize, and the first ripened squash play the principal roles. This ceremony, a vital component of the whole peyote complex, is the chief ritual through which the shaman inculcates the children of the extended family or of several related *ranchos* with the sacred itinerary of the peyote quest. Incessantly pounding his ritual drum and chanting all the while, the shaman "transforms" the children into a flock of hummingbirds and then leads them on a mythical pilgrimage to Wirikúta. On the way, all the sacred places at which the ancestral gods stopped on their primordial peyote quest are pointed out. The climactic event of the symbolic flight is the children's reception by the Mother Goddess Niwetúkame, who resides in the peyote country "in a field of precious flowers."

Just prior to the departure of the pilgrims, they and their relatives gather for the Huichol rite of sexual purification, a prerequisite to the sacred journey. Imagine a group of Indians, men and women, most of them married or otherwise related to each other, gathering around the ceremonial fire ("Our Grandfather") to identify every sexual partner since puberty. Not only spouses but current and former lovers are also present, awaiting their own turns for public "confession" and naming. And then imagine that the audience accepts what it hears, not with disapproval, recrimination, or tears, but with the best of humor, even high spirits. Instead of angry denunciations, there are shouts of encouragement and occasionally a merry reminder from a husband or wife of a love affair or two that was forgotten or concealed in one's recitation before the officiating shaman.

This purification ritual enables the participants to shed their earthly existence and become, temporarily, transformed into "newborn" spirit beings. Everyone—not only those who go on the pilgrimage but also their relatives who remain at home—is obligated to undergo complete sexual purification, "to become new," as the Huichol say, and to do so with frankness and absence of rancor. To show, even to feel, anger at anyone else at this time would immediately endanger the social and supernatural equilibrium and thus place the entire journey in danger. The offender would almost certainly be misled by evil sorcerers into picking the wrong kind of hallucinogenic plant and would suffer monstrous visions instead of perceiving the beauty of the ancestral ways that comes about with peyote. Or he would mistake a spiny cactus for a woman and rush to embrace her, only to find himself impaled and lacerated.

Beyond his personal misfortune, his people would suffer. No peyote dreams would reveal the past or the future. There would be neither rain nor babies nor new maize nor protection from pests or lightning. The very survival of the community would be threatened.

For each love affair that is publicly acknowledged, the shaman ties a knot in a special sisal fiber cord. After lightly brushing the head, chest, arms, legs, and pubic region of the pilgrim with his ceremonial hawk-feather arrows, he sends each on a leftward circuit around the fire.

The fire represents Tatewarí, Our Grandfather, the First Shaman, tutelary deity and guardian of shamans, and principal god in the crowded Huichol pantheon. It was Tatewarí who led the first peyote pilgrimage. According to myth, he met with the assembled supernaturals in the first temple, and when they complained to him of all manner of aches and pains, he told them they would be cured only by making the difficult trek from the mountains of the west to Wirikúta. In accordance with that tradition, on each such journey the officiating shaman or candidate shaman assumes the identity of Tatewarí and is so addressed by his companions, just as he calls them by the names of the gods who followed Tatewarí on the prototypal pilgrimage.

This ceremony, like the peyote hunt itself, appears to be wholly pre-Christian, fundamentally different from Catholic confession. It is not "sin" the Huichol confess and from which they are absolved. Rather, it is their identity as sexual beings. "Tatewarí burns it all away," intones the shaman as the pilgrims shake their arms and legs over the dancing flames—the men gesturing the rising heat up their wide, embroidered sleeves and pants, the women lifting their skirts to expose their sexual organs to the cleansing fire. When everyone, including the shaman himself, has confessed, the shaman rolls up the cord, now crowded with many knots, and carefully places it into the center of the fire.

By symbolically obliterating all memory of sexuality, the shaman transforms his companions and himself into a presexual or asexual newborn state. In fact, that is precisely how the Huichol put it: "We have become new, we are clean, we are newly born." They have become transformed into pure spirits, at least for the duration of the sacred and emotion-charged pilgrimage. For only when man has become spirit can he successfully pass through the mythically dangerous passage, the Gateway of Clashing Clouds, which divides the everyday, mundane world from Wirikúta, the sacred peyote country.

That this passage is today located only a few yards from a heavily traveled highway seems to matter not at all to the Huichol. On the journey they act as though the twentieth century had never happened. As a matter of fact, nothing I saw on the 1968 pilgrimage demonstrated more dramatically the time-out-of-life quality of the whole enterprise than the sight of the peyote seekers acting out their deepest beliefs on the very edge of the city of Zacatécas.

We arrived at the outskirts of Zacatécas in midmorning. Assembling in their proper order as decreed by Tatewarí, the pilgrims proceeded in single file to a grove of low-growing cactus and thorn

bushes a few hundred feet from the highway. They listened with great care as Ramón related the relevant passages of the peyote tradition and invoked the protection and aid of Elder Brother Kauyumárie, the divine Deer who is the shaman's spirit helper, for the coming ordeal. At Ramón's direction, each then took one small green and red parrot feather from a bunch carried by a *matewáme* (one who has not previously gone on a peyote pilgrimage), and tied it to the branches of a thorn bush, presumably to symbolize the flying journey of the bird-children in the chanting ceremony, and their own transformation into birdlike spirits.

Some distance up the road the pilgrims were led to an open space that commanded a magnificent view of the valley from which we had just come. Here they formed a semicircle; men to Ramón's left, women and children to the right. Although they knew the peyote traditions by heart, they listened with rapt attention as he told them how, with Kauyumárie's assistance, they would soon pass through the perilous Gateway of the Clashing Clouds. But from now until they reached the Place of Our Mothers, those who had never been to Wirikúta would have to "walk in darkness," for they were "new and very delicate." Starting with the women, Ramón proceeded to blindfold the novices. Even the children had their eyes covered.

Everyone took the blindfolding seriously, some actually wept, but there were quick shifts between solemnity and humor. Dialogues ensued between Ramón and veterans of previous pilgrimages. Was the companion well fed, had he quenched his thirst? Oh yes, one's stomach was full to bursting with all manner of good things to eat and drink. In truth, none had had more than the most meager nourishment for days. No water was permitted, and of solid food, the daily fare consisted mainly of five dry tortillas.

Following the blindfolding ceremony, Ramón took the pilgrims some hundreds of yards northeastward. Here, on a little rise of dusty adobe on the edge of Zacatécas, a place entirely unremarkable to the untutored eye, was the mystical divide, the threshold to the peyote country. The pilgrims remained rooted where they stood, intently watching Ramón's every move. Some lit candles. Lips moved in silent or barely audible supplication. Ramón bent down and laid his bow and arrows crosswise over his shaman's basket—bow and quiver pointing east in the direction of Wirikúta.

There are two stages to the crossing of the critical threshold. The first is called The Gateway of Clouds; the second, Where the Clouds Open. They are only a few steps apart, but the emotional impact on the participants, as they pass from one to the other, is enormous. From here one travels through a series of ancestral stopping places called Where Our Mother Dwells, the sacred maternal waterholes where one asks for fertility and fecundity and from where one first sees the distant mountains of Wirikúta. One would search in vain on any map for places that bear such names either in Huichol or Spanish. Like the other sacred places on the peyote itinerary, these are landmarks only in the geography of the mind.

Visually, the passage through the Gateway of the Clashing Clouds was undramatic. Ramón stepped forward, lifted the bow, and placing one end against his mouth while rhythmically beating the string with

At the foot of the Wirikúta Mountains, pilgrims search for peyote. When plants are found, below, some of the roots are left so the plant will continue to grow.

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an arrow, walked straight ahead. He stopped once, gestured (to Kauyumárie, we were told later, to thank him for holding back the cloud doors with his horns), and set out again at a more rapid pace, all the while beating his bow. The others followed close behind in single file. Some of the blindfolded held on to those in front, while others made it as best they could.

Whatever the event might have lacked in visual drama for an uninitiated observer, there was no mistaking its impact on the participants. Their faces reflected the emotional stress of this critical passage, their deep commitment to its truth, and their relief and pleasure that Ramón proved to have the power to transport them safely through the clashing gates.

We arrived at the sacred waterholes in the late afternoon. The physical setting was hardly inspiring: an impoverished Mestizo desert pueblo; a cluster of waterholes surrounded by marsh a few hundred yards beyond the last adobe huts. On the peyote quest, however, it is the reality of the mind's eye that matters. It is beautiful, the Huichol say, because Our Mothers live here, and because it is the wellspring of the water of life.

The pilgrims were conducted in single file to the edge of the bog. There they set down their bundles and the gourds, bottles, and flasks they had brought to be filled from the springs, and proceeded to pray with great fervor toward the east and Wirikúta. Those who were not blindfolded unpacked offerings—ceremonial arrows, thread crosses, animal crackers, yarn designs, candles, and votive gourds—and laid them out "for Our Mothers to see." Such offerings gain greatly in effectiveness by being impregnated with the life-giving fluid of the springs.

For the blindfolded novices, the enforced period of sightlessness was about to end, for much of what went on about them was designed to prepare the way for their "emergence into the light," their birth. This was also true for the others, since everyone was to be ritually washed and internally purified with the water of Our Mothers. Only after the washing ceremony would they be capable of perceiving the sacred country around them.

Just as the blindfolding before the crossing of the dangerous passage can be understood both in terms of metamorphosis and of return to the womb, the manner in which the divine Mothers "receive" the pilgrims can be recognized as symbolizing birth or, better, rebirth.

As part of the purification process Ramón scooped up a gourdful of water, lifted each pilgrim's hat or scarf, and, in the case of a *matewáme*, removed the blindfold. With sweeping gestures he pointed to the east, exclaiming, "There, companion, now you are able to see! Behold now the sacred places," and poured the contents of the bowl over the latter's head. Subsequently the companion was given his "first food," bits of tortilla and animal crackers that had been softened by soaking in sacred water. This is baby food, and its purpose is to reinforce the symbolic condition of newness, of having just been born.

Wirikúta is typical Chihuahuan desert, with an average altitude of 5,000 feet, covered with creosote bush, mesquite, tar bush, agave, yucca, euphorbia, and many kinds of cactus. The Huichol say, "It is beautiful here, very beautiful," and one has the feeling that they really mean it. Presumably, when they say that the desert here is covered with "flowers of brilliant colors," they are speaking of peyote, since *flower* is often used as a metaphor for the sacred hallucinogenic cactus.

As the peyote seekers walked toward Wirikúta, they picked up bits of dry wood and branches of creosote. This was food for Tatewarí. It is another mark of the total unity of the peyote seekers that each, down to the youngest, is expected to participate in the first "feeding" of the ceremonial fire when the fire is brought to life by the shaman.

The line stopped, Ramón squatted, and seconds later there was a wisp of blue smoke and a tiny flame. Speed and skill in starting the fire are of the essence, for one is in precarious balance in this sacred land and urgently requires the manifestation of Tatewarí for protection. The fire is allowed to go out only at the end, when sacred water is poured on the hot ashes.

It was midmorning when Ramón signaled the beginning of the hunt. Everyone gathered up his offerings and stuffed them in bags and baskets. About three hundred feet from camp we crossed a railroad track and beyond it a barbed wire fence. The men had their bows and arrows ready. We had walked perhaps five hundred feet when Ramón lifted his fingers to his lips in a warning of silence, placed an arrow on his bowstring, and motioned to the others to fan out quickly and quietly in a wide arc. He crept forward, crouching low, intently watching the ground. The women hung back.

Suddenly, Ramón halted, pointed to the ground, and whispered urgently, "His tracks, his tracks!" About twenty feet ahead stood a small shrub. He pointed: "There, there, the Deer!" Barely visible under the bush were some flecks of dusty green, evidently a whole cluster of peyote. Although I have seen the plant growing in full sunlight, more often it is found like this, in a thicket of mesquite or creosote, shaded by a yucca or euphorbia, or close to some well-armed rabbit-ear or cholla cactus. Since its broad, flat crown is usually almost level with the earth, it is easily missed by the inexperienced eye.

Ramón took aim; the first of his arrows buried itself a fraction of an inch to one side of the nearest plant. A second hit slightly to the other side. A pilgrim went forward and fired a third, almost straight down. Ramón then completed the "kill" by sticking a ceremonial arrow into the ground on the fourth side, so that the sacred plant was now enclosed by arrows.

The companions formed a circle around the place where Elder Brother lay "dying." Many sobbed. All prayed loudly. Ramón explained how the life essence of the deer was "rising, rising, like a brilliantly colored rainbow, seeking to escape to the top of the sacred mountains." "Do not be angry, Elder Brother," he implored, "do not punish us for killing you, for you have not really died." The pilgrims echoed Ramón: "We will feed you well, for we have brought you many offerings. We have brought you tobacco, water from Our Mothers, maize, and your favorite grasses. We have come from afar to greet you."

Ramón then took his knife from the basket and began to cut away the earth around the cactus. Instead of taking the peyote out whole, he cut it off at the base, leaving a bit of the root in the ground. This was done so that "Elder Brother can grow again from his bones." Dividing the cactus into five pieces by cutting along the natural ridges, he placed these pieces in a votive gourd. The process was repeated with several additional plants, for there had to be enough to give each of the companions a part of Elder Brother's "flesh." One by one the pilgrims squatted or knelt before Ramón, who removed a section of peyote from the gourd and, after touching it to the pilgrim's forehead, eyes, larynx, and heart, placed it into his or her mouth. The pilgrim was told to "chew it well, chew it well, for thus you will see your life."

Now the actual peyote harvest commenced, and the pilgrims went off into the desert, alone or in pairs. Almost at once, Lupe, Ramón's wife, discovered a thicket of cactus and mesquite so rich in peyote that in a couple of hours she had filled her tall basket. Occasionally she would stop to admire and speak quietly to an especially beautiful plant and to touch it to her forehead, face, throat, and heart before adding it to the others. We also saw people exchanging gifts of peyote. This seemed to us a very beautiful aspect of the pilgrimage. No ceremony in which peyote was eaten communally went by without this kind of ritual exchange. A man or a woman would carefully divide a plant, rise, and walk from individual to individual, handing over a piece and receiving one in return.

The first peyote plants found are cut up so that each pilgrim receives a portion of Elder Brother's "flesh."

No plant was dug carelessly or dropped casually on the ground or into a basket or bag. On the contrary, it was handled with tenderness and respect and addressed soothingly by the hunter, who would thank it for allowing itself to be seen, call it by endearing names, and apologize for removing it from its home.

Toward 4:00 P.M. Ramón signaled that it was time to return to camp. "Our game bags are full," he said, "one must not take more than one needs." If one took more, Elder Brother would be offended and would conceal the peyote or withdraw it altogether, so that next time the seekers would walk away empty-handed. We would call this conservation; to the Huichol it, like the peyote exchanges, is part of the principle of reciprocity by which they order their social relationships and their relationship to the natural and supernatural environment.

As a part of the hunt's ritual, each pilgrim divides his peyote and shares it with others.

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When their bags and baskets were heavy with peyote, the pilgrims gathered their gear and after a tearful farewell returned to camp as they had come, walking in single file to the sound of the bow.

The night was for singing, dancing, chewing peyote, and above all, for dreaming. After the excitement of the pilgrimage and the hunt, one would have expected the group to be subdued and quiet. True, some did appear to be removed; others entered trance states. But for the most part, they were in various states of exaltation, possessed by seemingly boundless energy. After the singing and the dancing, and after stories of the first peyote pilgrimage had been recounted until well past midnight, Ramón put down his fiddle and let the peyote take complete hold of him, squatting by the fire and staring into the darkness as he spoke directly with Tatewarı and the ancestral deities.

As a rule, the Huichol regard their peyote experiences as private and do not discuss them with anyone except in the most general descriptive terms, such as references to colors or visions. Under certain conditions, the shaman may be called upon to assist in giving form and meaning to a vision, especially for a novice.

The next morning, the pilgrims circled the fire as required and made their offerings of tobacco and bits of food and sacred water from the springs of Our Mothers. They purified their sandals and then wept bitter farewell tears to Elder Brother and Tatewarí. Then they left Wirikúta as they had entered—on foot, in single file, and blowing horns. During the night it had drizzled, and their once white clothing was now caked with the yellow earth of the desert. Behind them a thin plume of smoke rose from the deserted ceremonial fire.

A few hundred yards down the trail, they halted. Facing the mountains and the sun, they shouted both their pleasure at having found their life and their pain at having to depart so soon. "Do not leave," they implored the supernaturals, "do not abandon your places, for we will come again another year." ■

On the night of the harvest, pilgrims come under the effects of peyote. They dance and sing, below, early in the night, while later many, like the woman at right, enter trances that last until morning.

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Last Dance on the Mating Ground

The research ship Calypso *runs afoul of a swirling mass of procreating squid*

by Jacques-Yves Cousteau and Philippe Diolé

In April, 1969, the team of the *Calypso* was occupied with the study of gray whales; we were following their migration from San Diego to the lagoons of Baja California. On April 12 we anchored for the night off the island of Santa Catalina, in water 120 feet deep. Suddenly the ship's siren sounded—as it does whenever one of the engines overheats—and our maintenance officer rushed below. The electricity went off, and the water pumps were no longer working. The emergency lighting system was activated.

We made our way up to the deck, and what we saw from there made us forget about lights and water pumps. The sea around us, which only a few moments before had been almost completely calm, now seemed to be boiling. The ship was surrounded by millions of animals thrashing in the water. Obviously, it was necessary to find out what was happening, so two of our divers suited up immediately and jumped into the water. It was as though they had plunged into a kettle of squid. All around, *Loligo opalescens* were in motion.

At the request of the maintenance engineer, the divers inspected the screens over the intakes of the water pump. As suspected, they were blocked by the soft bodies of the squids. The divers pulled them away from the screens by the handful. But as soon as the pump was started again, more squids took the place of those that had been removed. Once more the pump stopped, and we had to improvise. Using metal wire, we made large baskets and fastened them over the intake openings. Then we appointed a clean-up team to clear away the squids every two hours.

By then I had decided that we could not afford to let this opportunity pass; we had to film this extraordinary spectacle in the sea. As soon as electricity was restored, I had all of our underwater lighting apparatus hooked up. The cameras were made ready, and my son Philippe joined the other divers in the nocturnal squid bath around the *Calypso.*

It was the first time that we had seen squids along the California coast. Now they were a veritable living tide, hundreds of thousands of tiny diaphanous ghosts in the midst of which submerged floodlights traced patterns of gold in the black water.

I had all of the *Calypso*'s lighting equipment turned on and aimed out at the unbelievable sight. We were in the middle of an almost solid layer, several yards thick, of writhing, squirming creatures, most of them not more than four inches long, that darted to and fro by expelling water from their funnels, like a vast fleet of minute jets or a giant puree of hyperactive microbes magnified millions of times.

In the midst of this mass of squids, sharks were cutting wide swaths, which quickly reclosed. With their great jaws wide open, they gulped down squids as fast as they could fill their mouths, then stopped for a second to swallow their prey before beginning again. We could see them shaking their heads and twisting their bodies in an effort to swallow more quickly.

The mass of squids was so dense that it was impossible for the divers to see for more than two feet ahead of them beneath the surface. Squids stuck to their arms, hands, masks, and lights.

And what was this great gathering of squids about? Seen from beneath the surface, its purpose was obvious: it was nothing less than a lovers' rendezvous; the squids were searching for partners. Dancing face to face, some of the animals were in pairs and swimming with their tentacles intertwined. Others were embracing in groups and clusters of five or six individuals.

In certain of these groups, nothing could be seen except a writhing mass of arms and tentacles. Isolated individuals were searching frantically for partners and attaching themselves to any

The mating is over, and the eggs for the next generation have been laid; now, in death, the squid becomes a meal for a scavenging bat starfish.

RON CHURCH, PHOTOGRAPHY UNLIMITED

From Octopus and Squid: The Soft Intelligence, *by Jacques-Yves Cousteau and Philippe Diolé. © 1973, by Jacques-Yves Cousteau. Published by Doubleday & Co., Inc.*

Entwined in the mating embrace, two squids pass over the mass of egg capsules on the sandy bottom.

RON CHURCH, PHOTOGRAPHY UNLIMITED

other squid, male or female; in their excitement, they ran into our lights and cameras, making it almost impossible to do any shooting. We frequently had to stop and turn out the lights. I was aware that this rendezvous of squids held the makings of a film as unusual as it was unexpected. It seemed to me especially remarkable that these usually timid little cephalopods, which one hardly ever sees except at depths of between 350 and 1,000 feet, were suddenly so obsessed with mating that they allowed themselves to be touched, and even captured, by our divers. Philippe and his companions brought aboard a great many specimens, which we immediately placed in an aquarium; but the cook, without telling anyone, fished them out with a strainer and prepared them *alla Romana* for lunch the next day.

We had all learned long before to bend to the whims of the sea. When the sea wishes to share its secrets, it does so, and we must plan our own affairs accordingly. In this light, the observation of gray whales lost its immediacy, and we decided to try to film, for the first time in open water, the complete mating cycle of the squids.

We laid out a program of shooting that would run twenty-four hours a day and cover all phases of the cycle. The cameras and diving equipment were checked out thoroughly, for this was to be an exceptional undertaking. We would compile a scientific record of the mating habits of *Loligo opalescens*, a common squid of the west coast of North America.

The subject of this record was not without some importance. Squids, which provide food for many species of marine life, are an essential link in the alimentary chain of the sea. Biologists are alarmed at the lessening of their numbers in certain areas that had in the past been excellent fishing grounds.

Thanks to the underwater television cameras that we were using, we could see that sharks were not the only animals devouring squids. There were also pilot whales, porpoises, fifty-ton sperm whales, and even moonfish taking advantage of this windfall. Many species of fishes, from salmon to swordfish, eat squids. Birds—auks and terns, for example—also claim a share. And finally, man eats squids in great numbers. Each year, between 500,000 and 700,000 tons of the species *Todarodes pacificus* are caught in the waters off Japan, and the Japanese are even beginning to breed squids in underwater "ranches."

The uncontrolled fishing of squids could cause an irreversible disequilibrium in marine life. I could not help imagining what disastrous consequences the use of a net might have had at the spot where the *Calypso* was anchored during the mating of these animals.

During our second night with the squids, they rose, as they had the preceding night, to the waters near the surface. The nuptial dances, however, seemed fewer than before, and there was a corresponding increase in actual matings. This announced the beginning of seventy-two consecutive hours of violence, fecundation, and agony.

I asked the divers to try to film pairs separately, within a wide frame. One might as well have tried to film two snowflakes in a blizzard. Meanwhile, our television team kept continuous watch over the progress of the mating, and in the dark sea, lighted by our floods, we witnessed one of nature's great dramas.

It seemed that sexual contacts were dictated by opportunity, and polygamy was the rule. Threesomes were quite frequent, and in their erotic frenzy, males attacked other males they encountered. Violent pitched battles then took place.

In the course of the mating, the squids' color changed frequently and radically. Their normal hues are rather delicate, iridescent, and diaphanous. But in the throes of desire, the males were purple. At the summit of excitement, while they were embracing females, their heads and tentacles were surrounded by wavy stripes of red and maroon.

Gradually and slowly, the squids began to sink toward the bottom of the sea. The females were depositing capsules, each containing a hundred eggs. For three days each of them laid between ten and twenty cylindrical capsules. But the females did not simply lay the eggs and then abandon them to their fate. They attached each capsule to algae or to some irregularity on the bottom by means of a viscous filament, thereby preventing the eggs from being washed away by the current into less temperate waters. Most of them arranged their eggs in bunches that resembled chrysanthemums.

Even while engaged in these maternal tasks, the females were not safe from assault by males. The males were still emitting their semen into the water, near the bunches of eggs; and the capsules were soft enough for the spermatozoids to penetrate and fertilize the eggs. This, however, is not the ordinary means of fertilization. Most often, the spermatophores are deposited on the female herself.

Our divers filmed these scenes with such concentration that they forgot there were sharks in the vicinity. Nonetheless, these predators were present in great numbers, attracted, no doubt, by the frantic movement of the squids. Squids are among the fastest swimmers in the sea, and, given their small size, they are not an easy prey. But at this particular moment, blinded by their sexual obsession, they were particularly vulnerable. The irony of it was that they were being devoured by sharks during their single opportunity to create life.

When it came time to shoot the scientific part of our film we invited June Lindstedt, a zoologist associated with the Laboratory of Marine Biology of the University of Southern California, to come aboard the *Calypso*. A specialist in this squid species, she was interested in our work and kindly accepted our request for help.

By using a special camera, we were able to record the mating of the squids. The male seized a female from underneath and to the side. Although the action was extremely rapid, our photographs allowed us to make out the details: the male held the female while the tip of his sexual member, or hectocotylus, slid under her mantle and reached the oviduct. He repeated this operation several times before relaxing his embrace.

It was less than seventy-two hours since the orgy in the sea began, and already our divers were reporting signs of fatigue among the squids. Many now rested on algae, drooping and limp.

Miss Lindstedt pointed out that there are three distinct and successive distributions of spermatozoids. The first takes place when the male penetrates the female and places spermatophores in her body cavity. The second occurs when the eggs are laid, at which time the female disposes of the spermatozoids stored by her. And the third takes place when the male emits semen into the water near the eggs that are attached to the bottom.

The eggs of the squid are de-

AL GIDDINGS, BRUCE COLEMAN, INC

A female begins to lay her eggs, attaching them to any irregularity on the ocean floor to prevent them from being swept away by currents.

veloped in the ovary, and when they cross the oviduct a protective envelope is formed around them. The entire mass is then expelled through the funnel, with considerable effort on the part of the female. The first thing to emerge from the funnel is a filament—a sort of anchor line. Once the capsule of eggs is entirely free of the funnel, it rocks back and forth until the female is able to seize the end of the filament with her arms. She then uses the filament to anchor the capsule to the ocean bottom. We observed that the laying of eggs lasted three or four days.

On April 16 many females no longer had the strength to complete their work, to expel the last of the capsules containing their eggs. Others, exhausted by having given life, were on the point of death. Some, still alive, were locked in the embrace of males, who would take the females with them into death. The long night of the squids was about to end.

Using our two minisubs, Albert Falco and I discovered thousands of egg capsules and innumerable corpses on the bottom. Nothing moved, other than one last squid, barely alive. Twenty million pale cadavers covered the flat, sandy floor of the ocean.

Two days later I asked the divers to reconnoiter the bottom in order to determine the extent of the area over which the squids' eggs were spread. On the basis of this information, we hoped to estimate the size of the generation that would be born here.

The divers were surprised to discover a female still living in this field of death. She was trying to eject her egg capsules. One of the divers helped her. It is not often that one can play midwife to a squid.

Over the bottom we saw large gray rays devouring either the dead squids or their eggs. The rays' wings suddenly took on a sinister aspect; they somehow reminded one of the angel of death.

The divers went down every day to inspect the immense nest below us, an incubator in which seven billion embryos were alive. (This was the approximate figure at which we arrived.)

From day to day, the eggs changed color. In the light of our lamps, we saw them becoming darker and darker. This brownish color was due to tiny mushroomlike growths that covered the egg capsules. Moreover, the capsules themselves had grown harder.

Very few predators now attempted to attack them. Only starfish, whose stomachs are proof against anything, eat squid embryos. Even so, the capsules were tough, and it took a starfish three or four days to digest them. Starfish, therefore, will attack capsules only when there is nothing else to feed on.

I decided to dissect one of these capsules and examine it under the microscope. It was so elastic that it was difficult to cut, even with a scalpel. From the jellylike mass I took a single transparent chorion. It was almost an individual aquarium, constituting an ideal environment that responds to all the needs of the embryo. The color of the tiny form already had a sparkle discernible with the naked eye. Under a powerful lens, one could see a perfectly formed squid palpitating with a life-force that has come down to it from ancestors whose origins go back 200 million years. Under such a lens, the skin of the embryo already seems pigmented in a fashion reminiscent of a mosaic.

Thanks to Miss Lindstedt, we were able to follow, and then to film in the laboratory, the entire embryonic development of the squid *Loligo opalescens*.

Inside the capsule, the eggs were tightly packed; but in each egg there was sufficient space for the embryo's movements and growth. Three swellings within the embryo were already distinguishable. One would become the mantle and most of the internal organs. The arms were already visible under two lateral swellings. Another would become the eyes and a part of the brain. The central mass was the yellow exterior sack of the embryo—the yoke of the egg. We could even make out the sucker disks on the arms, and the eyes were already completely formed.

In order to emerge from the egg, the embryo makes use of a special organ situated between its two fins. Shaped like a two-pronged fork, this organ secretes enzymes that dissolve a part of the membrane of the chorion. At the same time, the organ, activated by vibrations, perforates the wall of the embryo's cell. The embryo leaves through the breach, using its jet propulsion for the first time to emerge from the egg.

Upon hatching, a baby squid measures one-tenth of an inch in length. It immediately manifests great activity. Strangely, its first act is to shoot out a jet of ink.

Our experiences during the month we spent at Santa Catalina have given us some idea of the place that death occupies in the history of a species. Twenty percent of each generation of squids die before hatching, mostly because of changes in the environment. Fifty percent of newborn squids are devoured by predators during the first week of their life. Those who survive are the sole hope of the species.

By May 18 we had been working off Santa Catalina for more than a month. I sent the divers down for a final inspection of the area in which the eggs were laid. They reported that visibility was excellent, and that biological activity was negligible. Where the squids had assembled by the millions, where they mated, and where a new generation was born, there was nothing left. Everything had disappeared. Where the infant squids first emerged into the water, there now remained only an eternally mute witness: the sea. ■

Secured by filamentous anchor lines, the leathery egg cases are immune to the attacks of most predators. Starfish may feed on them when no other food is available.

BILL DECOURT, PHOTOGRAPHY UNLIMITED

The Cones of Cappadocia

Early Anatolian peasants, retreating from hot summers, cold winters, and invading armies the year round, carved their homes in volcanic rock

by Roberta Strauss Feuerlicht

Paul Lucas, who in the early 1700s traveled to Asia Minor on behalf of Louis XIV of France, is believed to have been the first person from western Europe to pass through Cappadocia and record what he saw. Lucas's description of the contorted Cappadocian landscape was received with such skepticism that French officials wrote to Constantinople to verify his veracity and perhaps his sanity before financing another journey.

The German poet and scholar Christoph Martin Wieland scoffed at Lucas's report of men living in cones in Cappadocia, noting that "traveled persons are inclined to tell extravagant stories, and to exaggerate what they have seen, and I cannot affirm that Paul Lucas is wholly free from this universal weakness. . . . Can anything be more incredible than that there can exist such a vast host of pyramids excavated into ordinary dwelling houses? For they certainly did not spring from the earth like mushrooms. . . ."

Wieland was right, but for the wrong reason; nothing could be more incredible because, if anything, Lucas understated, rather than exaggerated, what he saw. Since his caravan did not actually stop at Cappadocia, he did not examine the cones; he merely assumed they were built by men. In an engraving he made of Cappadocia, the cones are shown as a cluster of orderly, nearly identical tepeelike forms. But there is nothing orderly about the Cappadocian landscape; the cones are neither man-made nor did they spring from the earth like mushrooms. Nature shaped all of them from without; man shaped some of them from within. Of the two collaborators, nature was the more violent, the more creative, the more unpredictable.

The boundaries of the land in Asia Minor that was known in classical times as Cappadocia have changed during the course of history, but at its core is a triangular area covering some 30,000 square miles, which, on a map of modern Turkey, has as its three points Aksaray on the west, Kayseri on the east, and Niğde on the south. Along the southeast boundary is a chain of volcanoes with five main peaks and many lesser ones. The highest of the volcanoes is Erciyaş Dağ.

During the Miocene, Pliocene, and Pleistocene epochs, these volcanoes spewed layers of cinder, ash, and lava onto the plains and valleys of the Cappadocian triangle, creating a plateau of volcanic deposits. As the volcanic masses cooled, fissures appeared. Rain and melting snow formed streams that, as they drained down toward the Kizilirmak and other main rivers, enlarged the fissures into gullies and chasms. While water was slicing through the soft volcanic stone at the base of the deposits, wind, weather, and windblown sand gnawed at the sides and tops. Since the rate of erosion varied according to such factors as compactness of stone, existing fractures, wind direction, and river flow, the result was a landscape of hallucinogenic lunacy.

Almost in defiance of the erosion process, some of the volcanic tuff stands in solid cliffs. For the most part, however, nature has sculptured the soft stone into myriad shapes. Most are conical, but some are columnar; some are isolated, while others are attached or semiattached; some are worn down to small mounds, while others tower 300 feet or more. Except when the setting sun paints them in warm oranges, the cones tend to be mushroomlike grays and browns, highly polished by windblown sand. Many of the pinnacles are topped by a harder and usually darker stone, sitting solid and pointy like a dunce cap or rakishly tipped like a beret. This more compact tuff retards the erosion process, but when it finally decays, the cone soon follows.

The Anatolian peasants who now inhabit the area have turned to the supernatural for explanations of the cones' origins. One local legend is that the tall pinnacles are enemy soldiers turned to stone by Allah; another holds that a giant put the caps on the cones with one hand. Some of the cones are referred to as *peribacalari*, "fairy chimneys."

No one knows what the first set-

Many cones, no longer inhabited by man, have been converted into pigeon dwellings. The tall cliffs of Üzengi are pocked with symmetrical dovecotes carved into the soft, volcanic stone.

ALL PHOTOGRAPHS—HERBERT A. FEUERLICHT

tlers called the cones because the identity of these people is uncertain. Situated in the center of Asia Minor, Cappadocia has served since prehistoric times as gateway and battlefield between East and West, a natural highway and meeting place for traders and armies. The area was settled about 5000 B.C. by Anatolian people organized into small states ruled by local princes. In about 2320 B.C. seventeen of these rulers formed a coalition to battle the invading Assyrians. The Assyrians were victorious, but only temporarily: in later centuries Cappadocia passed from conqueror to conqueror, empire to empire. The Assyrians were followed by the Urarteans, the Hittites, the Phrygians, the Lydians, the Persians, the Macedonians under Alexander the Great, the Seleucids, and, as the Christian era began, the Romans.

As foreign armies advanced and retreated, Cappadocia's indigenous population managed to maintain a degree of relative independence, with their own rulers, language, and religion. The ruling and middle classes lived in towns along the borders, which served as military and trading posts, while the peasants settled into the eroded interior to produce food for the occupying army of the moment. Since there are only two seasons in Cappadocia, fiery summer and freezing winter, shelter was necessary. Wood was scarce so the people turned to the ubiquitous volcanic stone. While it was possible to use this stone to build houses, and many did, at some point in the history of Cappadocia men discovered that it was easier to carve a stone house than to construct one. The volcanic tuff, so soft that it crumbles under a fingernail, could be easily shaped with even the most primitive tools. In a Cappadocian cone or cliff anyone could hollow out a shelter that was warm in the winter and cool in summer.

In the face of almost constant conflict, the Cappadocians also discovered that the same stone was soft enough to tunnel underground. Layer by layer entire cities were chipped out to a depth of 265 feet or more. After the Persians marched across Cappadocia at the beginning of the fourth century B.C., Xenophon wrote in the *Anabasis:*

> The dwellings in these villages are underground: they have an entrance like the mouth of a well, but the rooms are spacious. The livestock lives in separate apartments hollowed out of the ground; the men go down into them with ladders. Here they rear goats, sheep, cows, and hens, together with their progeny: and all these beasts are fed solely on hay. They keep stores of corn, rice, vegetables, and barley wine in large jars: and in some of the wine jars grains of barley can be seen floating, clustering together round the rim; and they have hollow reeds of varying size, which are used to suck up wine from the jars by any who are thirsty and desire to drink. This barley wine is exceedingly strong and is best mixed with water: but any man who is accustomed to it and drinks it undiluted enjoys its flavor to the full.

Undiluted barley wine was only one of the comforts available to Cappadocians who moved into the underground cities for months or years to escape invasion or persecution. Two such cities—connected by a tunnel nearly six miles long—have been uncovered at what are now Kaymakli and Derinkuyu. The Kaymakli dig sinks seven stories deep, although only four levels have been excavated thus far, and is said to have held as many as 20,000 persons.

A maze of passageways led past private family alcoves, with carved-in beds and shelves, to communal kitchens and workshops. At every entrance, huge stone slabs stood ready to be rolled into place when danger was imminent. Even with all doors sealed, ventilation shafts provided fresh air and, beyond a certain depth, also served as wells, tapping water from underground sources for the inhabitants who, if the passageways are any guide, were short and broad. After Christianity came to Cappadocia, chapels, altars, and crosses were added to the underground abodes.

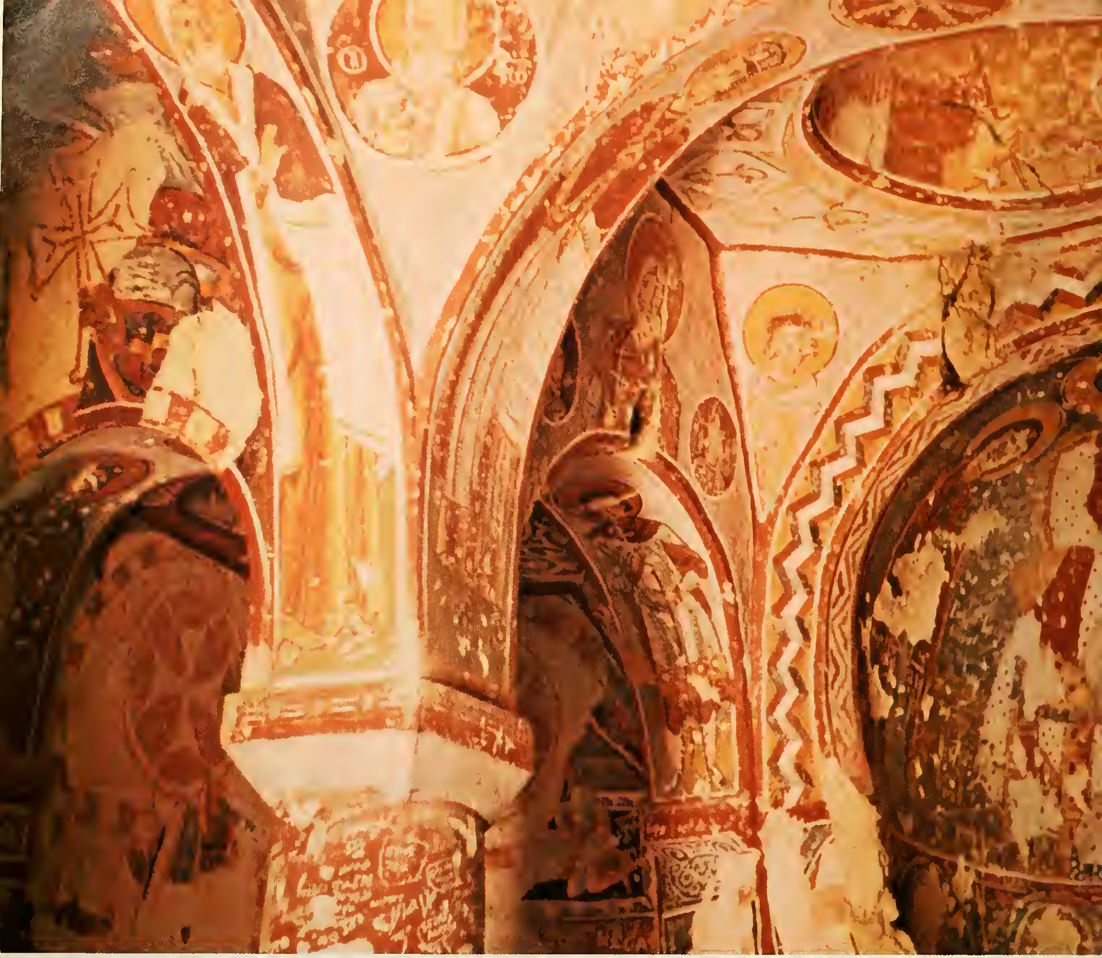
The domes are often topped by a harder and usually darker stone, which retards the erosion of the softer volcanic rock underneath.

Christianity came early to the area: in the New Testament, Peter is described as preaching in Jerusalem to "the dwellers in Mesopotamia, and in Judaea, and Cappadocia" (Acts 2:9) and Paul crossed Cappadocia on a missionary journey. By the end of the second century A.D. Cappadocia's capital, Caesarea, now Kayseri, was an episcopal see and in 381 it came under the authority of the patriarch of Constantinople. Thereafter, the religious and esthetic impulses of Cappadocia were dominated by Byzantium.

In the fourth century Cappadocia produced three great bishops, Basil of Caesarea, Gregory of Nyssa, and Gregory of Nazianzus, under whose influence cenobitic and eremitic movements flourished. The strange environment suited the life of a monk or hermit; here an ascetic could carve and contemplate from his own cave. Where better to think about God than in this unworldly environment, which offered the additional advantage of being relatively inaccessible to all but the most intrepid invaders or persecutors?

At first, each man hollowed out his own cell and chapel in a single room. Later, as religion became more institutionalized, the cenobitic and the secular Christian communities required a place for group worship. Since worship requires an altar, the Cappadocian Christians

Although falling boulders make the caves unsafe, many families still inhabit them, adding wooden doors, locks, and windowpanes.

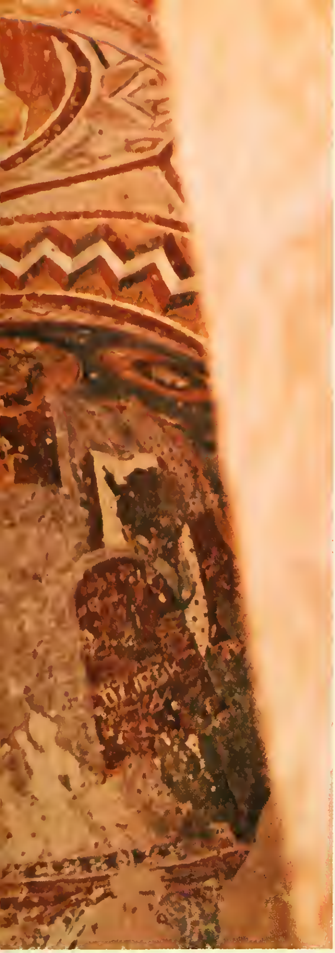


In imitation of Byzantine architecture, the Elmali Kilise has elaborate columns, which serve no structural function in a cave, and highly detailed frescoes.

carved an apse niche into the stone and created a cave church.

The popular reply to the question of how many churches there are in Cappadocia is 365, or one for every day of the year, but there are actually more than a thousand. Rock churches are scattered throughout Cappadocia, but most of them are concentrated in three areas: around Göreme and Soğanli and in the Peristrema valley near Aksaray. With cruciform plans, vaulted ceilings, domes, columns, pilasters, and arches, many of the churches are brilliant, if bizarre, imitations of virtually every variety of Byzantine ecclesiastical architecture. In some instances the outsides of the caves have been carved into cupolas and other church forms, but these have no relationship to the internal plan of the church since in cave construction one does not depend upon the other, as in masonry work. Generally the masters of Cappadocia worked only within the vast masses of volcanic stone, not building a church in the ordinary meaning of the term but removing the excess stone; what remained was the church. Often the internal components of the church have no relationship to each other either; vaulted ceilings are natural to a cave, but many of the columns have no structural function since the domes stand without them.

About the sixth century, Cappadocians began to decorate their cave churches; some 150 of them contain carvings or paintings. Authorities on this cave art differ on questions of dating, on Byzantine vs. Syro-Palestinian influence, and on whether nonfigurative paintings represent the iconoclastic period or were merely the whim of the artist. The paintings range from simple de-



signs, applied directly to cave walls, to the most elaborate narrative frescoes. In the Church of Saint Barbara at Göreme, for example, the stone has been smoothed, a thin coat of slaked lime applied, and awkward figures and abstract designs drawn in red ocher with some black and white. Nearby, however, are three highly sophisticated cross-domed columned churches, Carikli Kilise (the Church of the Sandal), Elmali Kilise (the Church of the Apple), and Karanlik Kilise (the Dark Church). Within these are frescoes that rival the highest achievements of Byzantine art. But the frescoes have been severely marred by graffiti, dating from the seventeenth century, stones thrown by vandals, and erosion. In the Dark Church, aptly named because the only light enters through one window in the north corner of the narthex, the frescoes cannot be seen except by artificial light, but it is awesome to stand below the entrance and look up at the soaring arch bared when one wall of the cave collapsed.

Perhaps the most impressive rock church in Cappadocia is also at Göreme. Called Tokali Kilise, or Church with the Buckle, because of two huge gold ornaments that were once fixed to the ceiling, it has a transverse barrel vault supported by two transverse arches. The frescoes include the story of Jesus from Annunciation to Ascension.

The soaring arch of the Karanlik Kilise, or Dark Church, was bared when one wall collapsed.

At the same time that religious communities were carving and painting chapels, churches, and monasteries in Cappadocia, secular communities were also burrowing into the soft rock. Some families carved out their quarters in private pinnacles, while very tall cones were turned into apartment dwellings, with one family living above the other, to a height of ten stories.

On the flat rooftop of a home in Ortahisar, apricots dry in the hot Cappadocian sun.

Irrigated with water carried from springs, and fertilized with pigeon guano, fruit trees and vines grow amid desolate volcanic cones.

To get from one level to another the inhabitants used chimneylike tunnels bored through the center of the cones. In some areas virtual cities were honeycombed within the shanks of volcanic cliffs. Everywhere, household furnishings—beds, pillows, tables, benches, and cabinets—were shaped directly into the stone.

The cones were used not only as living quarters but for all the other necessities of community life as well. In Zelve there is a cave mill with the huge millstone still in place. At Göreme one of the caves has been identified as a jail, with eight cells and holes in the walls between the cells to hold the ropes or chains that secured the prisoners.

Most of the dwellings and churches were built high above ground level, and people entered them by rope ladder or by finger- and toe-holds scooped into the rock. When enemies threatened, the rope ladders were raised and a thick slab rolled across the cave entrance. If the danger was serious and persistent, the community took refuge in one of the underground cities.

As eastern outpost of the Byzantine empire, Cappadocia was a magnet for conquerors. In the seventh century A.D. the Persians invaded and were repulsed, but for the next 300 years the Arabs fought Byzantium for control of Asia Minor. The Byzantines won, and from about the mid-tenth to the mid-eleventh century, peace reigned in Cappadocia. Monasteries throve, new churches were built, towns expanded. Then the Seljuk Turks attacked, and in August, 1071, Sultan Alp Arslan defeated and captured Byzantine emperor Romanus IV Diogenes.

The Moslem Seljuks were tolerant of their Christian subjects, who continued to build and decorate churches in Cappadocia even as mosques, turbehs (tombs), and caravanseries began to rise in central Anatolia. In Zelve there is one mosque built into a volcanic rock wall. But in the years that followed, Byzantium received a crippling blow when Constantinople was sacked by the Crusaders and Venetians. Thereafter, Asia Minor was witness to new wars—between Crusaders and Turks, between Turks and Mongols, and between different Turkish tribes fighting for ascendancy, with the Ottomans the ultimate victors.

As the Byzantine empire died, so did monasticism and church building in Cappadocia (although there were some Christian communities in Anatolia until the 1920s). While the rock churches fell into disrepair and disuse, the cones offered shelter to the Turks, who had begun to move into the area in the twelfth century. As recently as thirty years ago, people still lived in such cave communities as Zelve and Üçhisar, until falling boulders became so hazardous the government forced them to move. Some families, preferring their cave homes to the houses provided in nearby villages, quietly moved back. Others still use the caves for storing and drying food, but where once a stone may have guarded a cave entrance there is now a thick wooden door and a secure lock.

Today transient hippies and campers use the caves as they find them because they offer free shelter, but the Anatolian peasants usually modify the stark stone with some modern amenities. Brick walls reinforce eroded areas. Some cones have framed glass windows, a street number on the front door, and a fence around the family garden. There are many combinations of masonry and stone. In some villages, such as Ürgüp, most of the inhabitants live in false-front houses built against the side of a tufaceous cliff. The built-on front rooms provide light and air; behind them the family can burrow into the cliff as far as necessary to enlarge the apartment for sleeping or storage.

Men, women, and children work fields of volcanic soil enriched by pigeon guano. The fertilizer is so vital that pigeon farming is a major occupation in Cappadocia, and many of the cones have been made into nesting places. In the village of Üzengi, tall volcanic cliffs are pocked with dovecotes that house hundreds of thousands of pigeons. The guano is used by the local farmers and also sold to other peasants. The fields scattered among the volcanic detritus produce grains, vegetables, and fruits, and are said to be the original home of the apricot. In late summer, bright patches of apricots drying in the sun are visible in the crannies of cones, on rooftops, and wherever there is level ground.

Many of the local women still wear traditional Moslem garb—trousers and veils—and weave carpets using native plants and herbs for dyes, but signs of modernization are appearing throughout the area. It is somewhat jarring to see, for example, the name of one village, Ortahisar, in a red neon sign atop a high volcanic cone. There are many such cultural shocks as Cappadocia seeks to encourage tourism, hoping that tourists will provide the funds and impetus needed to preserve and restore the rock churches and to build dams, which will slow erosion and irrigate crops.

Just as early Cappadocians offered travelers barley wine, and Moslems built caravanseries for their comfort, the contemporary inhabitants welcome tourists in contemporary style. Inside one handsome twin cone is a bar that serves soft drinks, while amplified rock music reverberates off its rock walls. And in the underground city at Kaymakli, past low, dark tunnels of archeological, geologic, historical, and architectural marvels is one last room open to the public. There, some 65 feet below ground, over the ancient doorway carved out of volcanic stone, is a painted sign that says DISCOTEK. ■

The Black Rhinoceros

In its world of scents and trails, mud baths and dust wallows, not much gets in the way of this behemoth. Except its two-legged enemy

by John Goddard

The full moon, which illuminated the open ground, did not penetrate the darkness behind the line of vegetation. Far away a night bird called, and an occasional grunt or shriek told of some unseen drama in the plant cover. Slowly, a huge gray form emerged from the shadow of a crooked acacia tree. Sniffing the well-used path, it lumbered down the bank toward the slow-moving river. At the water's edge it unhurriedly began to sip its fill. Two horns cast their silhouette against the silvery water.

By dawn the animal was several miles from the river, chewing on shrubs and bushes in the soft morning light. At midmorning, when the sun's heat began to tell of the day ahead, the animal settled down in the fine soil of an eroded termite hill and dozed until late afternoon.

The appearance of a black rhinoceros dominates almost any setting. Its bulk, encased in a thick, armorlike hide, serves as an efficient defense against almost all would-be predators. Reaching a length of twelve feet and weighing up to two tons, rhinoceroses have survived without the constant awareness of their surroundings so typical of the fauna of the African range—where death can follow an instant of carelessness. More ancient than many of the animals of the plain and savanna, they have followed along their scented trails since the Miocene. The formidable size and strength of a mature black rhinoceros also protects its young. Mother and calf are commonly seen ambling across the vast African landscape while other animals cautiously eye and stalk each other.

At birth a black rhinoceros calf weighs about 85 pounds and superficially resembles a small pig. Within a few hours it can stand and follow behind its mother, and whenever she stops, the young calf attempts to suckle, often butting its small head impatiently against the two-teated udder. While it is very young, the mother tolerates this rough behavior, but as the calf

grows stronger, she often kicks it gently away. Wherever the mother goes, the calf follows closely. When it grows larger, it often walks at her side; in this way, the young calf becomes oriented to its complicated habitat of shapes and scents.

During this period the young calf is most vulnerable to predation. At moments of danger, it instinctively snuggles close to the mother's side. This behavior usually deters any attack. I have witnessed five attempts by hyenas to grab young calves, all unsuccessful.

To lure the calf away from the mother, the hyena moves close in, in front of the calf, attempting to provoke a charge. Unless it comes very close, the mother usually ignores the hyena. If the calf charges, the hyena runs just ahead of it, slowly drawing it away. Then, when the calf has been enticed some distance away from the mother, the hyena will suddenly turn and attempt to grab one of the calf's extremities—an ear, the tail, or part of the hind leg. The calf, in its sudden terror, emits a loud squeal, and this distress signal brings an immediate and aggressive response from the mother in the form of a charge toward the hyena; the latter usually releases its hold quickly and lopes away. A calf is normally vulnerable to predation by hyenas only until it is about four months old. By this

Fighting can occur when one bull enters the home range of another. The animals often inflict deep bruises and cuts, which may fester for a long time.

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age the calf has grown so large that hyenas will no longer attack it.

Calves, and rarely adults, are preyed upon by lions, but since lions are opportunist hunters, they do not make frequent attempts to tackle a rhinoceros. One attempt by a male lion to kill an eleven-month-old calf was observed in Ngorongoro Crater in Tanzania during August, 1966; it ended with the lion being gored to death by the mother. Normally, adult rhinoceroses show little fear of lions, often walking deliberately in the direction of a pride as soon as they are aware of its presence.

If a young calf loses its mother, it is more vulnerable to predation, but orphaned calves will seek to join up with another mother-calf group, which offers some protection. Sometimes even fully grown bulls will adopt orphans. Twice I have seen adult bulls in company with young calves; on both occasions the pair fed and wallowed together, and traveled as a social unit.

A cow that is raising a calf usually does not successfully mate again until her offspring is approximately a year old and half her size.

Courtship can be a prolonged affair, and bulls will occasionally battle for the favors of a female. The bull is extremely cautious in his approach to the cow, which sometimes responds by knocking him around. The pair usually stand facing one another, gently rubbing horns. Depending on the receptivity of the cow, the bull either mounts her immediately or gallops away in a small circle, returning with a hesitant, short-step approach. This behavior may continue for several hours until mating eventually occurs. The mating bond is very impermanent, and observations of rhinoceros behavior in the wild indicate that the species is both polygamous and polyandrous.

The gestation period of the black rhinoceros ranges from 15 to 18 months. When the calf is from two and a half to three years old, it is ready for life on its own. Independence comes quickly; when a female gives birth to a new calf she will not tolerate the presence of her previous offspring.

The older calf is reluctant to leave the family group. On numerous occasions I have seen a young rhinoceros following its mother and her new calf at a distance of about fifty yards. If it follows too closely or if the mother becomes aware of its presence, she charges and chases it away. By now, however, it is thoroughly familiar with its surroundings and will establish a home range, part of which will be the area in which it lived as a calf.

Adult black rhinoceroses are basically solitary: bulls are frequently observed alone, and the usual pair-unit is the cow and her calf. However, home ranges of individuals can overlap considerably, providing frequent opportunities for contact between individuals.

The home range varies in size from six to fourteen square miles according to population density and to the availability of food and surface water. In areas where there is a supply of vegetation and water throughout the year, the rhinoceroses are extremely sedentary. Where food is not plentiful and water supplies are scattered, the home range tends to be larger. There is evidence that the rhinoceros can survive in some regions without free water, possibly by feeding on moisture-rich plants.

In general, immature animals cover a larger home range than adults. When a calf is rejected by its mother, it invariably attempts to join up with another rhinoceros as soon as possible. If tolerated, it normally stays with its new companion, which may be an adult or another immature individual. The rejected calf sometimes joins an adult whose home range overlaps, but extends farther afield, than the calf's. The movements of the immature animal are governed by the movements of the adult, thereby extending the former's range into new areas.

The larger home range of the immature animal and the mother's rejection of her old offspring may serve an evolutionary function: they assure population dispersal in a species that is sedentary and therefore susceptible to the effects of inbreeding. Studies suggest that population dispersal occurs when the animal is young; adult rhinoceroses show no tendency to disperse into

The black rhinoceros is primarily a browsing animal, although it does feed on ground plants. Its long upper lip enables it to strip leaves from branches.

The behavior of kicking apart dung piles may be related to the laying down of scent trails. Feces, which adhere to this cow's hind feet, could leave an odor along her path that other rhinoceroses would recognize.

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new areas, even when the opportunity arises. They cling to their home ranges, probably staying within them for their entire lives.

Scent plays an important role in the lives of these animals and is probably responsible for the extensive behavioral repertoire performed at their dung piles. The animals sniff extensively at these deposits, thrashing their heads and upper lips from side to side in a wide sweeping motion. Occasionally they will use their horns to root in the deposit, followed by a shuffle through it with their front and hind legs held stiffly. The animal then defecates and scatters the droppings with sharp kicking motions of the hind legs. Even very young calves engage in this behavior.

The habit of kicking their dung had led to some fanciful interpretations in folklore. One version has it that the elephant does not like to see dung piles nearly the size of its own. It expressed its disapproval to the rhinoceros, which solved the problem by scattering its dung around. Another interpretation is that the rhinoceros is such a bad-tempered animal that after defecating, it turns around and in a fit of fury breaks up the pile.

If one watches an undisturbed rhinoceros on its home range, it can be seen that the animal walks with its head held close to the ground; actual sniffing can sometimes be detected. On observing this one afternoon, it occurred to me that the animal could be following some kind of scent trail, and that the explanation of the dung-kicking habit may be quite simple. By kicking and actually shuffling through the piles, a rhinoceros smears its hind feet with dung, which will leave a scent trail imprinted behind the animal. It could thus orient itself by following scent trails that are already set down in its home range, either its own or those of other, nearby animals.

Wallowing in a puddle coats the black rhinoceros with a layer of mud. This protects the animal against the numerous insects that feed on it.

To test my theory, I collected samples of feces from one rhinoceros, from other individuals whose home ranges overlapped that of the test animal, and from animals several miles distant. The samples were placed in new, carefully washed net bags, and then towed behind a vehicle as close as possible to the experimental animal.

While the results were inconclusive, they did demonstrate the ability of a rhinoceros to follow fecal scent trails. On one occasion a dung sample was collected from a rhinoceros; 48 hours later it was towed—at a speed faster than the animal could travel—from a point directly in front of the animal to another point two miles away. The route was zigzagged to determine if the animal actually followed the set trail; it did exactly, and in 38 minutes it was back alongside the vehicle, still sniffing the trail laid by the sample. It may be that the rhinoceroses in a given area can indeed recognize each other by scent trails and dung piles. Visual contacts would thereby be minimized and potential conflicts avoided. Given the animal's poor eyesight and pugnacious disposition, such an ability could have significant adaptive benefits.

The black rhinoceros has a hooked prehensile upper lip admirably adapted for browsing. This lip is, in fact, a miniature trunk. It can be curled around a leafy branch, which is then sheared with the front premolar teeth, leaving a straight, clean cut as though snipped with a pair of hedge trimmers.

The animals feed on a wide variety of the woody plants available, rarely on grass. In one study area of East Africa they were observed eating nearly 200 plant species from 49 botanical families. In spite of this wide selection, the rhinoceros shows distinct preferences. It is particularly fond of legumes, and when feeding in an herb patch will often select only certain specimens of the same plant species. Others, which appear to be identical, are sniffed but not eaten, while dry or with-

JOHN GODDARD

A male rhinoceros often makes a number of cautious, short-step approaches—sometimes over a period of several hours—before a cow will accept his attentions.

ered plants are invariably rejected.

A major event in the day of a black rhinoceros is wallowing. In the rainy season the wallows may be seen all over the animal's home range; they are often old dust beds that have filled with rainwater. The wallowing animal thoroughly smears itself with mud; it rolls to one side, stands, then rolls on its other side. In this way the animal attempts to protect itself from the numerous biting flies and insects that feed on its hide. Dry wallowing in dust may serve a similar purpose.

The animals rest for a considerable part of the tropical day. Typically, they doze upright on their sternums; only occasionally are they seen lying flat on their sides. The bed is often in loose, fine soil adjacent to a termite hill, and several individuals will use the same spot over a period of time. Shade does not appear to be of primary importance in the choice of a resting place; I have often seen rhinoceroses resting in blazing sunlight, less than twenty yards from the shade offered by a large acacia tree. Even while dozing, their ears continue to rotate like radar antennae, alert for the smallest sound.

Rhinoceroses are often accompanied by tiny oxpeckers, which pluck parasites from their hides and ticks from skin creases, and feed on blood from the numerous sores frequently infesting the animals. When something unusual approaches, such as a man on foot, the birds screech and chatter. Occasionally they fly into the air, chirping loudly but quickly settle again on the animal. The rhinoceros is immediately alerted and will frequently walk or run away.

Only a few black rhinoceroses reach their potential life-span of about forty years. They often become mired in mud; sometimes they cannot extricate themselves. There are records of the animals charging trains and cars, often with fatal consequences. There are also records of rhinoceroses being killed by elephants. Little is known about the diseases that affect them, but they are known to be susceptible to various liver ailments.

It is the activities of man, however, that have caused the greatest reduction in rhinoceros numbers. Men have hunted them extensively because nearly all parts of the animal are used in folk medicine. For centuries they have played a role in a number of rituals and ceremonies, most of which required their sacrifice. In parts of Indonesia today, their blood is used at a deathbed ritual to facilitate the departure of a soul to paradise. Their urine is widely used as an antiseptic, and is believed to be a charm against evil spirits.

Perhaps the most unusual beliefs about rhinoceroses concern the properties ascribed to their horns. In parts of the Orient, the horns were made into goblets as gifts for royalty or aristocracy, for it was believed that these goblets could detect poison: a drink placed in them would supposedly bubble if poison was present. Interestingly, certain alkaloid poisons will effervesce when mixed with keratin compounds, the basic constituents of rhinoceros horns. The horn, placed under a bed, is also reputed to ease the labor of a woman in childbirth.

The most enduring belief about the horns is that when ground to a fine powder they will act as a potent aphrodisiac, but chemical analysis of the horn has not revealed any properties to support this. It seems possible that the belief arose partly because of the phallic symbolism that is apparent in the shape of the horn and partly because of the prolonged mating of the animal.

It is thought that the black rhinoceros formerly occupied approximately one-third of the land area of Africa south of the Sahara. Its distribution today shows that its range has been reduced considerably. There appears to be little doubt that contraction of its range has been brought about by indiscriminate poaching, hunting, and the destruction and modification of its original habitat by advancing agricultural settlement; the last factor has probably been most responsible for its disappearance.

Hunters have traditionally regarded the rhinoceros as one of the most dangerous beasts alive, but their accounts of encounters with the animals are often embellished beyond credibility. Rhinoceros heads, massive and seemingly menacing even in death, decorate trophy rooms and museums throughout the world. Books, journals, and periodicals abound with tales of the charging rhinoceros, the last-minute shot coolly fired at point-blank range, the narrow escape from certain death—these are the ingredients of a legend still implanted in the public mind.

As in all such stories, there may often be some element of truth. The rhinoceros will indeed charge, and the animal has been responsible for the death of hunters and others. But like most hunting tales about African animals, the danger is greatly overrated. The same tales fail to inform the reader that under certain circumstances it is possible to stalk to within ten yards of a black rhinoceros without it ever becoming aware of the observer's presence; that, protected by a tree or rock, a hunter can "call" a rhinoceros and shoot it from a distance of less than two yards if he is so inclined; that the attendant oxpeckers and cattle egrets invariably betray the location of the animal, allowing the hunter to take advantage of the element of surprise, or to take evasive action if necessary; and that the rhinoceros sometimes has considerable difficulty in detecting the source of danger even in sparse cover, presumably because of its myopia.

One major ecological problem that could seriously affect its welfare is the effect of other animals, most notably the elephant, on its habitat. Recent studies in East Africa have shown that in several of the great parks, overpopulations of elephants have resulted partly from natural increases under conditions of total protection and partly from dispersal from outside the parks, where agricultural settlement has taken over land formerly occupied by elephants. This has inevitably forced the elephant into areas of sanctuary, where they have had a marked effect on the vegetation, usually in the form of large-scale destruction of woodland. With the large amount of dead and decaying woody material and debris, hot ground fires sweep through, their spread aided by the inevitable in-

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A calf, which weighs about 85 pounds at birth, receives a rich supply of protein from its mother's milk. A cow lactates for several months.

vasion of the open areas by grasses. These fires, in turn, tend to kill off or retard new growth of browse. In general, the combined effect is to convert woodland to grassland, a process that could ultimately lower the carrying capacity of the park for the rhinoceros.

The sedentary character of the rhinoceros presents advantages and disadvantages for conservation of the species. It may be expected to survive in small isolated populations even though surrounded on all sides by cultivated areas. Conversely, when settlement invades its habitat, it shows no tendency to move away. In most such cases, it is eventually shot.

Boundaries of national parks and game reserves are usually established by some convenient reference to topography, roads, or watercourses, and rarely consider the migratory patterns of the animals that utilize the park. The black rhinoceros is a species that may be least affected by this and would be expected to receive adequate protection in well-patrolled game parks. However, the regular habits of some individuals make them easy prey for poachers who are familiar with their habits and daily movement patterns.

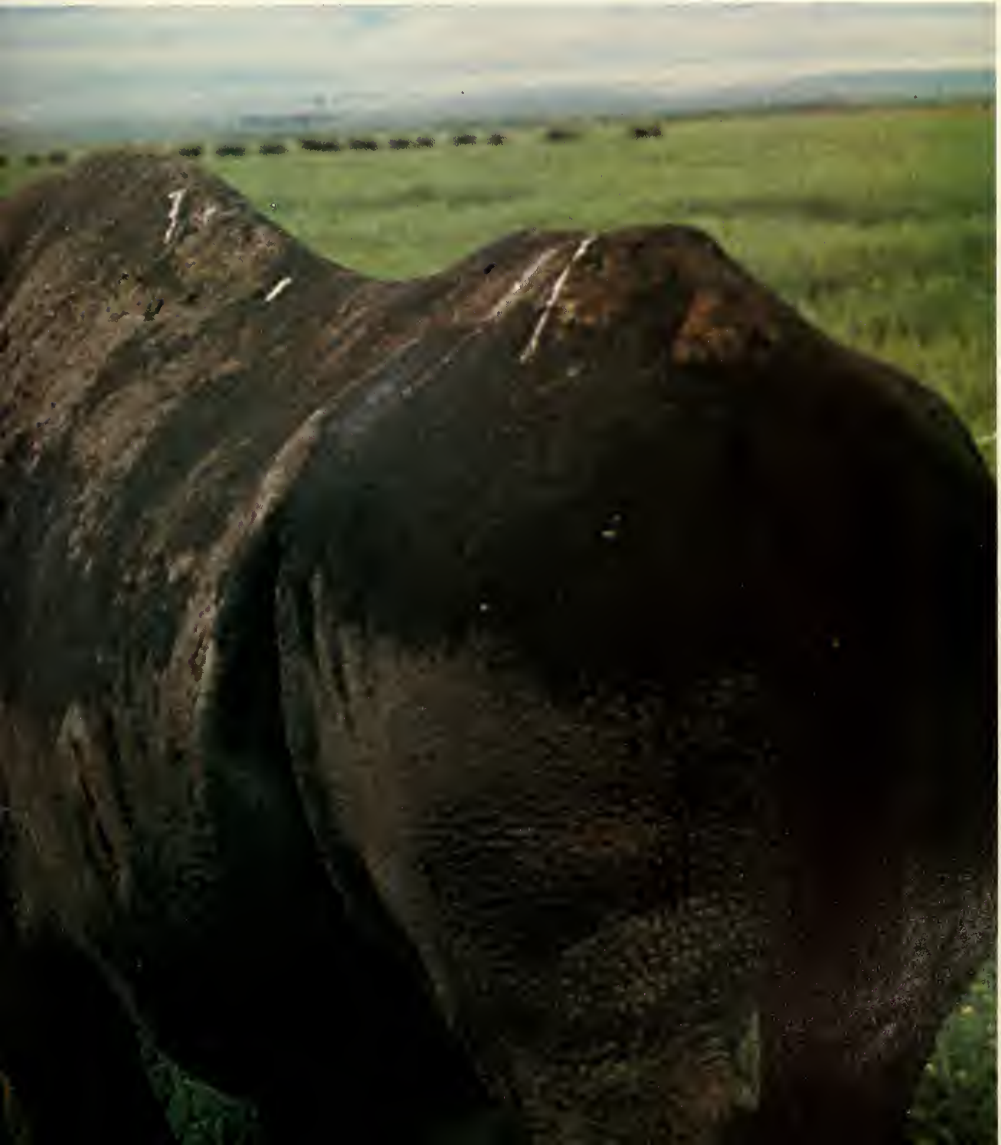
The late Arthur Ritchie, chief

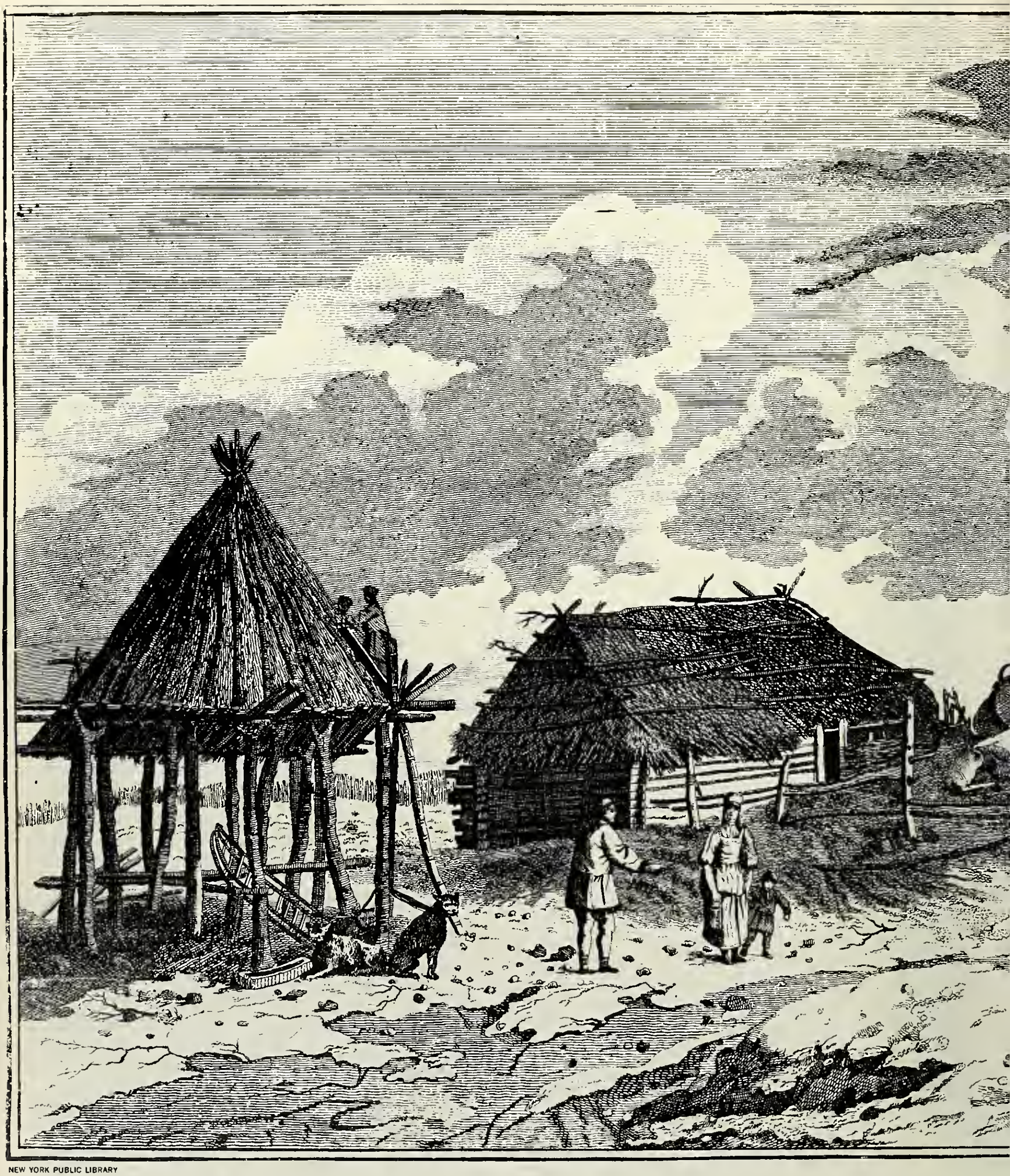
KOJO TANAKA, ANIMALS ANIMALS

game warden of Kenya from 1923 to 1948, was a fine field observer and naturalist whose special interest was the black rhinoceros. A decade ago he wrote: "In these circumstances, they will only survive in sanctuaries and reserves where their interests are absolutely paramount. In my belief there is no animal in the world today so greatly in need of skilled and sympathetic care and conservation. We must not neglect nor unduly delay the provision of such treatment."

His words are even more applicable today. Seemingly so invulnerable, these huge herbivores are dependent on a habitat that continues to shrink. In the end, the only hope for the black rhinoceros is that man will not be shortsighted, that he will understand and accommodate the needs of this ancient form of life. ■

Just prior to mating, a pair of black rhinoceroses will often engage in gentle, back and forth rubbing of their heads and horns.





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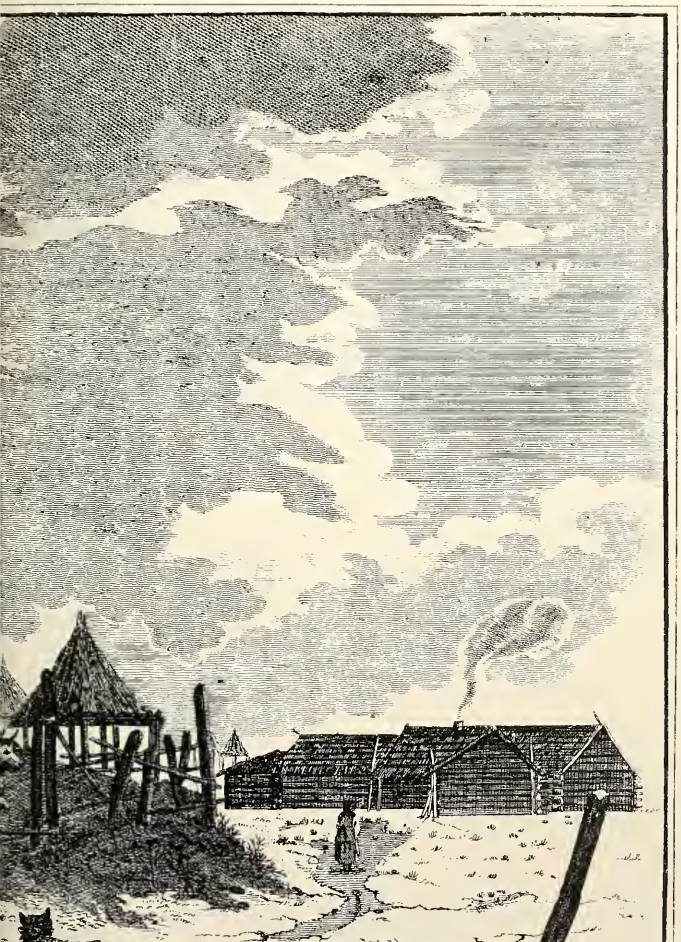
A Botanist at Sea

Recollections of a Siberian cruise made fifty-five years ago by a world-famous authority on pine trees who wisely preferred botany to navigation

by Nicholas T. Mirov



Street scene in Petropavlosk, capital of Kamchatka, from a late nineteenth-century engraving. The log huts are typical of Siberian dwellings of the period.

In the spring of 1916, I graduated from the School of Forestry in St. Petersburg, the old capital of Russia, and joined the navy. It was during World War I, shortly before the beginning of the Russian Revolution. I fought the Germans rather unsuccessfully, and when our destroyer was sunk, I traveled across the continent to the Pacific coast of Siberia looking for a job. I found it on the Bureau of Fisheries' ship *Dydymov*, scheduled to sail north for her annual cruise. It was my officers' training in navigation that won me the job, but as it turned out, it was my college training in botany that helped me keep it.

The *Dydymov* was named after a Russian Arctic explorer. She was a beautifully streamlined 350-ton steam yacht based in Vladivostok, on the Russian coast of the Sea of Japan not far from Korea.

One stormy evening in early July, 1918, when the northern seas had become navigable, the *Dydy-*

NICHOLAS T. MIROV

Petropavlosk harbor as photographed by the author during his visit in 1918. By then, houses made of American Douglas fir had replaced the formerly ubiquitous Siberian log cabin.

mov left Vladivostok for Kamchatka Peninsula. I had never been in a real storm before, and during my first night on the bridge, I was desperately seasick. The *Dydymov* was loaded with provisions and equipment for remote lighthouses and with mail for northern settlements—their first since the preceding summer. Among the passengers were fisheries inspectors and people with no other means of reaching their places of employment on Kamchatka or on the coasts of the Sea of Okhotsk; one traveler was even going north to the Commander Islands, between Kamchatka and the Aleutians.

In addition to Captain Alfred Lindholm, a Swede from Riga, there were two other officers on the *Dydymov:* the first mate, a bewhiskered and obese merchant mariner; and a clean-shaven second mate, who, although a lieutenant (j.g.), was totally inexperienced—me. We were the only two who stood the watch. For each of us that meant four hours on the bridge, four hours off for a meal and sleep, then four hours on again, and so on. The captain often appeared on the bridge but not on a definite schedule. He was an experienced navigator of the northern seas, a short, sparely built man of about fifty, with direct blue eyes that commanded trust and respect. From graying goatee to polished shoes, he presented a picture of neatness.

The voyage was exciting; everything was new to me, met before only in books. Each night I diligently recorded in my diary the activities and discoveries of the day. The *Dydymov* stopped in every bay and cove to deliver mail to the Russian, Estonian, and Korean settlements along the Siberian coast, and visited many fisheries leased to the Japanese by Russia.

Our first major stop was at the 560-mile-long island of Sakhalin, which lies north of Japan along the coast of Siberia, just opposite the estuary of the mighty 2,800-mile-long Amur River. Sakhalin had been discovered by the Japanese, then taken by the Russians. As a result of the Russo-Japanese War, Japan regained the southern part of the island in 1905, but after World War II the whole island reverted to Russia. At the time of our voyage, the northern half of the island was Russian; the southern half, Japanese. Before the Russo-Japanese War, Sakhalin had been used by Russia as a place of punishment and exile for criminal prisoners, who were shipped from Europe around the Cape of Good Hope.

The *Dydymov* had to take on some coal at Sakhalin, at a place not far from Aleksandrovsk, the capital of the Russian part of the island. It was a hot sunny day when we walked into town from the landing. The capital was located on the coastal terrace, about three miles from the sea across a swampy stretch of land dotted with reeds, buttercups, and blue iris. From the pier to the town there had once been a broad-gauge railroad, but the tracks were now deserted and covered with tall grass. Some abandoned flatcars were still standing on the track, but no locomotives were to be seen. There had never been any; the prisoners had pushed the loaded cars toward the town.

We passed by solid log warehouses, built like the kremlins, or citadels, of old Russian cities, and presently arrived at the main part of Aleksandrovsk. Everything looked sad and forlorn, as things did everywhere in that part of Russia in the summer of 1918. The streets were overgrown with grass, and few people were around. At one intersection we came to a cab stand with four or five old-fashioned droshkies lined up along the plank sidewalk. The skinny horses were drowsing, and on the sidewalk the drivers were playing checkers in the shade. In the second story of a blue-gray house, the windows were wide open and a gentle breeze moved the lace curtains. Somebody was hesitantly playing a Chopin prelude.

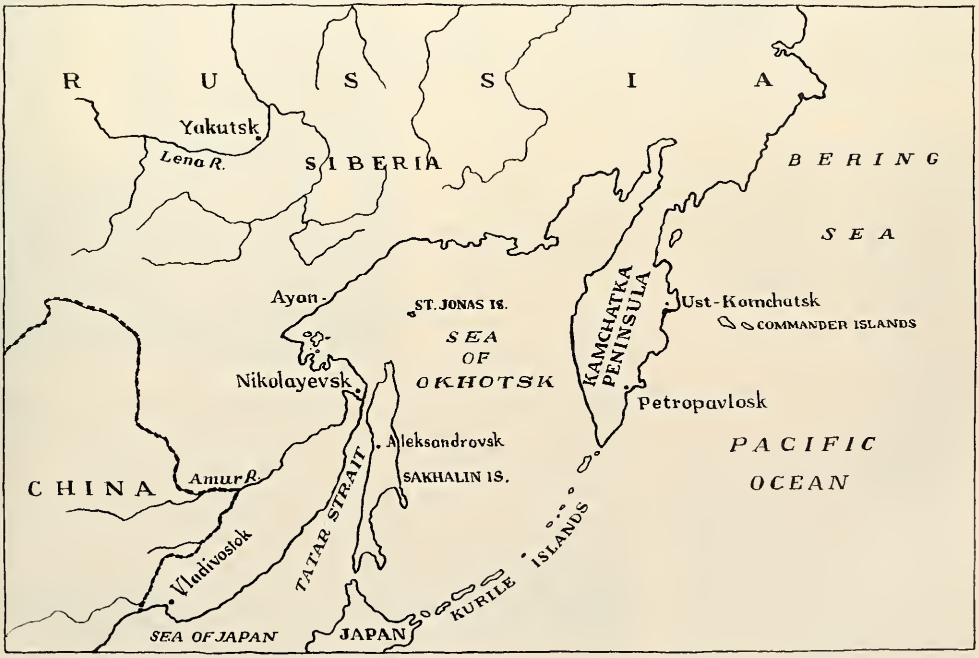
On the front porch of another blue-gray house sat an old man holding a smiling baby in his arms. He gazed at the child with infinite love. Paroled convicts were not permitted to leave the island, and many of them found jobs as servants. From the appearance of the man's faded clothing, I surmised that he was one of them.

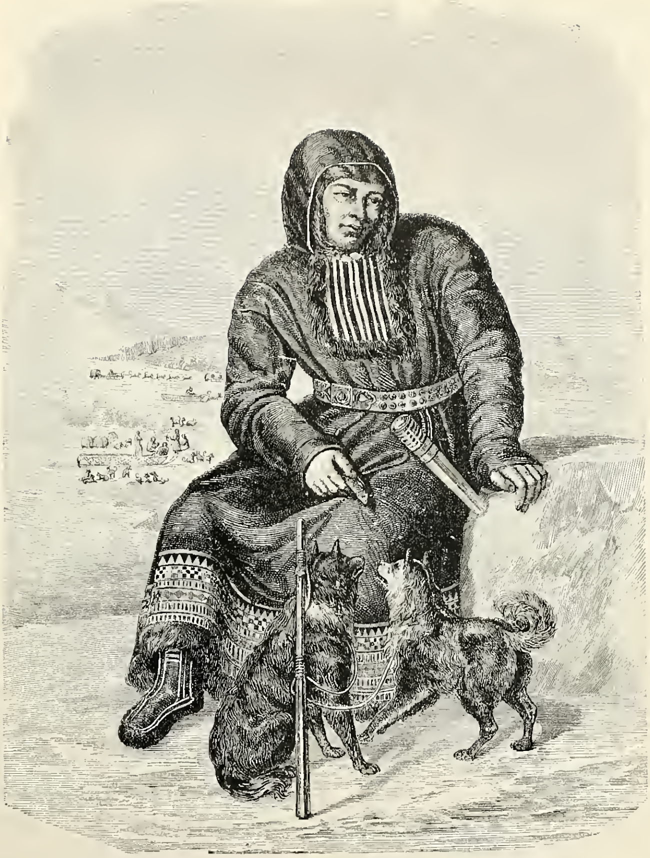
It was a long distance from Sakhalin to the next colliery and Captain Lindholm was not even sure that he would find an adequate supply of coal there. So he decided to load as much fuel as possible in Sakhalin. The whole upper deck was covered with standing gunnysacks of coal, overloading the ship. The portholes of the underdeck cabins and the wardroom were below the waterline.

We sailed at night and ran into such a violent storm that the *Dydymov* could not make any headway. To keep the ship facing the wind, the captain ordered the sea anchor dropped. Waves broke over the deck, tearing the coal bags to pieces and washing the precious fuel overboard. Soon, not a single bag was left. Toward morning the storm subsided and the ship, relieved of its top-heavy load, became more manageable.

We passed through the Tatar Strait and entered the Sea of Okhotsk, which lies on the latitudes between Bordeaux and Stockholm. Although it was the middle of July, there was still snow on the coastal mountains and the area looked wintry. We headed toward Ayan on the southwestern coast of the Okhotsk to disembark some passengers for the next leg of their voyage farther north and inland by pack reindeer.

Before Alaska was sold to the United States in 1867, the town of Ayan was the terminus of the 500-mile pack reindeer trail from Yakutsk, on the Lena River. It was once a busy port, where ships were built and sailed to Russian Alaska and where goods could be bought in an American warehouse. In the 1850s American fur-trading posts could be found along the pack trail, but at the time of our visit Ayan was barely alive. After fifty years of neglect, the port manager's two-story, blue-gray house with its white columns was in disrepair. The windows were boarded up and salty winds had eroded the paint. Ayan had a lovely church of fine proportions, also boarded up, and there were several warehouses and log dwellings. From the chimney of one house, smoke curled to the sky. The Ayan caretaker, a very old man, stepped out to greet us, accompanied by barking huskies and an interracial crowd of children—Russians, Yakuts, and Tungus—of all ages. Their Russian was difficult to understand: it contained Tungus words (Manchu language) and Yakut words (Turkic language), intermingled with the Siberian dialect of





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The Kamchadals, an aboriginal people living on Kamchatka before its conquest by Russia in the eighteenth century, used dogs and sleds for transportation.

Russian, which is an Indo-European language.

Some adult Tungus, eager for news of the outside world, joined the children to greet us. Awaiting our arrival, they had been camping with their pack reindeer behind the warehouses since the end of June. They were supposed to take passengers from the *Dydymov* to the lower Lena by reindeer, which they used both as mounts and as pack animals. They were typical Tungus: slim, wiry, and averaging not more than five feet four inches in height. Their complexions were dark olive and their features essentially Mongolian, with black, somewhat oblique eyes. The Tungus are noted hunters, and we were glad to buy from them some Ayan spruce grouse, a species closely related to the Canadian variety.

I had time to take a walk up the Ayan valley. The countryside was lovely. Snow had already disappeared from the valley floor, and cold, crystal-clear streams rushed and cascaded everywhere. Spring flowers were in bloom, and in the background, dark-green bristles of Ayan spruce (*Picea jezoensis*) projected against slate-blue snow-capped mountains. I returned to the ship with a bouquet of flowers; to my surprise, Captain Lindholm showed unusual interest in my botanizing. He said that plant collecting was his hobby, too.

At Ayan we took on coal, water, and two reindeer, a male and a female, for a reindeer breeding farm on Kamchatka. They were accommodated in a makeshift enclosure and tethered with ropes to the foremast just outside my cabin. Both had large, clumsy-looking antlers and dark, sad eyes. Unlike the cows of moose and elk, the female reindeer has antlers. Siberian reindeer and American caribou belong to the same species, *Rangifer tarandus*, but the former are more readily domesticated.

It was a bitter cold day when we left Ayan. About 200 miles from the coast, in dense fog, the *Dydymov* approached Saint Jonas, a high rocky island several miles in circumference, which sticks up from the depths of the Sea of Okhotsk. The temperature of the water was 32 degrees Fahrenheit. Captain Lindholm told me that it was easy to guess in fog how close the land is by watching the flight of seabirds: if the birds are cruising in broad circles just above the water, they are hunting for fish in the open sea; but if they are flying straight, they are returning to their nests on nearby rocks close to shore.

The *Dydymov* moved slowly by traverse course. Soon we saw hundreds of birds flying in the same direction and heard murmurs that grew louder and louder. Suddenly, Saint Jonas loomed up out of the fog. Densely populated with seabirds, there was no privacy whatsoever on the island. Each nest was barely out of pecking range of the next. The tops of the rocks and the gravelly beaches were covered with herds of sea lions (*Eumetopias jubata*), which roared like motorcar klaxons. The big, old polygamous bulls, ten feet long, were fighting one another, rearing like grotesque animals on medieval coats-of-arms. The cows lay on the rocks awaiting the outcome. When our men caught a calf, the sea lions attacked the whaleboat, almost overturning it.

Since Saint Jonas lay off the regular navigation course, ships seldom came close to the island. The *Dydy-*

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mov was sent there to study the sea lions and to see whether Japanese were in the area. They weren't.

It was a dismal, cold morning when the fisheries' inspectors began to study the eating habits of sea lions. After a day of slaughtering, they completed their study. The water around the *Dydymov* was red with blood, but little was added to scientific knowledge.

We next sailed toward the low, inhospitable west coast of Kamchatka to check on Japanese fisheries leased from Russia after the war of 1905. The fisheries were well-established settlements, with electric lights, crab canneries, and smoking chimney stacks—quite out of place in the primitive northern landscape. The canneries were running in complete disregard of specifications concerning the extent of catches.

The Kamchatka Peninsula is about 750 miles long and more than 250 miles across at its widest point. The southern part of the peninsula separates the Sea of Okhotsk from the Pacific; its northern part separates the Okhotsk from the Bering Sea. The west coast of Kamchatka is flat and tundralike, while the east coast is mountainous and volcanic. Most of the Kamchatka volcanoes are located on the east side of the peninsula. Some twenty of them are still active, causing frequent earthquakes and occasional eruptions. There are glaciers on the slopes of some volcanoes, but the lush valleys have hot springs and warm rivers where people can bathe even in winter. Spruces, aspens, and patches of curly Erman birch grow in the central part of Kamchatka. The middle slopes of the mountains are covered with alder thickets and dwarf trailing pine.

The original inhabitants of the peninsula were a Paleo-Asiatic (Americanoid) people, called Kamchadals in Russian or, more recently, by their native name of Itelmes. During the Russian conquest in about 1700, they showed extraordinary resistance and, like some of their American Indian cousins, often preferred to kill their wives and leap to their death from the rocks rather than surrender to the invaders. The diseases brought by the white man had nearly exterminated the Kamchadals; when I visited only about 2,000 of them were living on the west coast of the peninsula. There were some other Paleo-Asiatic and Tungusic tribes there, but the population was largely made up of Russian settlers, often racially mixed with the aboriginal population. Their language was sometimes difficult to understand, and their customs were not those of Russia. Fish was the staple food for people, cattle, and dogs. Bears were plentiful and protected by law, for they were easily procurable when other food was scarce. The Kamchatka bear (*Ursus pescator*) is a large, fierce animal. It thrives on salmon, which it fishes from streams with its paws; hence its name, *pescator*, or fisherman.

On Kamchatka we visited Petropavlosk, the capital. While there, I made several botanical excursions inland, and Captain Lindholm always joined me. Although his hobby was collecting plants, he often did not know their names. Relations between the captain and me, his second mate, were unusual. On the ship Lindholm was a most demanding skipper; when I did something wrong he cursed me, using maritime profanity in both Swedish and Russian. But during our botanical excursions, I was the master

The Yakuts, a native Kamchatkan ethnic group, were experienced hunters. Among their quarry were foxes and sables, which were once numerous on the peninsula.

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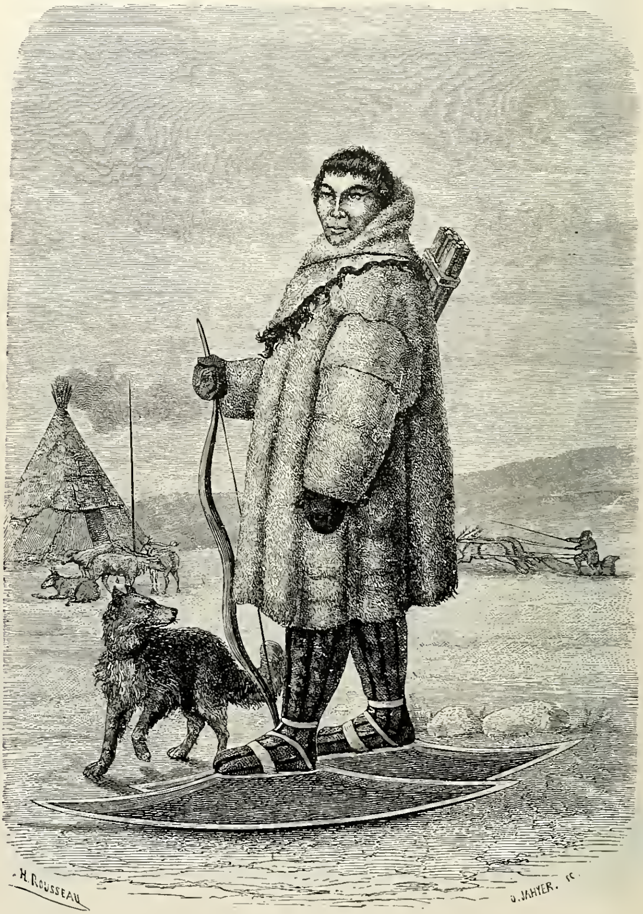

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Droshkies could still be seen in 1918 in the streets of Vladivostok, where the author's voyage to the northern seas began and ended.

and he the apprentice. I helped him identify flowers and explained the intricacies of plant reproduction. I called his attention to the almost complete absence of Compositae (the largest family of flowering plants) and Leguminosae (the very large pulse family) in the flora of Kamchatka. The genera *Astragalus* (loco weed) and *Oxytropis* of the latter family were exceptions.

As a whole, the plant life of Kamchatka is poor, consisting of not more than 800 mostly circumpolar species with an admixture of Sakhalin and Okhotsk coast plants. But we had fun and collected everything in sight. Our prize specimen was the rare endemic fir (*Abies gracilis*), which grew sparingly in the southern part of the peninsula.

Captain Lindholm listened to me as attentively as I had listened to my botany professor only five years before. During our voyage, the captain and I learned much about the botany of Kamchatka, and I learned even more about navigation in the northern seas.

From Petropavlosk, we sailed to a cove known to the captain as a convenient place to replenish our water cisterns. It was a lovely, sheltered inlet with a sandy shore and a narrow valley filled with snow that descended almost to the water. A stream, forming a waterfall as high as the roof of a one-story house, gushed from under the snow. We had to approach the shore in reverse, aft first, so that our water hose would reach the waterfall.

Captain Lindholm was on the bridge; my place was astern, where I was to make sure that the ship did not run aground. The snowy valley, the waterfall, the faint odor of flowers filled me with such rapture that I forgot to watch how many fathoms of water we had under the keel. Presently, the ship scraped the sandy bottom and bounced gently. At the same time a stream of Russo-Swedish swearing, amplified by megaphone, came from the bridge. The *Dydymov*'s propeller churned up the water and the ship moved ahead, away from the shore. She was not grounded and no harm was done, but my conduct had been unpardonable and my spirits were low. The hose was secured with rocks and water began to run by gravity to the ship's cisterns. But it took some time and I became more miserable. Then Lindholm came astern, and I stood at attention. He said, "We have at least one hour and a half here; let's go collect plants."

We climbed the steep slope of the valley just above the snowbank. Spring was there in all its beauty. Catkins of dwarf willows were fully open, faintly fragrant violets were blooming, and anemones on delicate stalks were pushing through the snow. And this was in the middle of August at the same latitude as London!

Next the *Dydymov* sailed north along the east coast of Kamchatka where the settlement of Ust-Kamchatsk—now probably a big town—is located at the mouth of the Kamchatka River. The settlement was on the same parallel as the two Commander Islands, a Russian continuation of the Aleutian chain.

During our cruising in these northern seas we encountered masses of seabirds: among them geese, ducks, and snipes on the low shores; murres, petrels, kittywakes, puffins, auklets, and guillemots on the rocky cliffs. Seagulls were everywhere. The total number of bird species was not large, but the number of individuals in each species was enormous. This is also true of northern fish. (The opposite condition prevails in tropical zones, where there are many species of few individuals.)

Behind Ust-Kamchatsk, the highest volcano of Kamchatka, Kliuchevskaia Sópka, rises from sea level to a height of 15,584 feet. (All volcanoes on Kamchatka are called *sópka*, meaning literally "she who wheezes or snores.") During our visit this *sópka* was covered with snow from an altitude of 3,000 to 10,000 feet. Above that level the volcano appeared as a perfectly symmetrical, slate-blue cone, clear of snow. Dense yellow and black smoke, like that from the gigantic chimney of a chemical works, poured from its crater.

At Ust-Kamchatsk the *Dydymov* transferred her cargo, including the two Ayan reindeer, to small boats. I wished the animals success in multiplying and populating their new environment.

Soon it was September. The *Dydymov* had accomplished everything planned for her and much that was unplanned. She had delivered mail, passengers, and freight

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to different places; the Bureau of Fisheries' inspectors had gathered enough material to write reports on sea lions, crabs, salmon runs, and the activities of the Japanese. It was time to return to Vladivostok. Captain Lindholm intended to sail south along the Pacific side of the Kurile Islands and stop at the port of Hakodate on the southern tip of Hokkaido, but a storm forced him into the Sea of Okhotsk. The new course took us between the islands of Paramushir and Onekotan, through the Fourth Kurile Strait.

After five stormy days and nights we entered the Tatar Strait from the north and then sailed up the unbelievably wide estuary and the low reaches of the Amur to the regional center and river port of Nikolayevsk-on-Amur. We did not stay there long; soon the *Dydymov* sailed again and, after several stops, approached Vladivostok late in the evening. At midnight I went to the bridge for my 12:00 to 4:00 watch. The captain said, "When you are on the traverse of the Vladivostok lighthouse, wake me up." After three months in the northern seas I had gained much experience in navigation, and a great deal of self-confidence. For the first time I disobeyed the captain's orders. When we had passed the lighthouse and safely entered the inner harbor, I ordered the anchor dropped. Lindholm quickly appeared on the bridge, probably even before the anchor reached bottom. But he merely asked, "Is everything all

Clothed in furs and animal skins, girls of a small Tungusic tribe perform a native dance in the snow at the turn of the century.

Tungus children learned at an early age how to stay on a reindeer's back. Often nomadic, these Siberian aborigines used reindeer until well into the 1900s as pack animals and individual mounts.

right?" and I said with satisfaction, "Aye, aye, Skipper."

Our summer cruise was over, and so was my short career as a mariner. It was a happy summer. Because of Captain Lindholm's patience, I learned to navigate a ship; because of his love of botany, I became familiar with the coastal physiography and vegetation of Sakhalin and Kamchatka, and of northeastern Asia from the Korean border to the latitude of the Aleutian Islands.

I subsequently found a forestry job in China, and soon moved to a lifetime career in forestry in the United States. The botanist in me won over the mariner, but I still look back fondly on my youthful voyage to the northern seas. ■

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Books in Review

People and Their Music

by Alan P. Merriam

IRMGARD GROTH KIMBALL

MUSIC OF THE AMERICAS, edited by Paul Collaer. *Praeger Publishers, $25.00; 207 pp., illus.*

Many kinds of specialists study music—musicians, psychologists, estheticians, musicologists, acousticians, biologists, and even anthropologists and sociologists. But one of the most expert of them all is seldom named, simply because he is little known to most of us. I am speaking of the ethnomusicologist, an expert whose concern, at least in theory, covers the music of all men everywhere, in the past but more often in the present, and whose view of music covers more than sound structure alone.

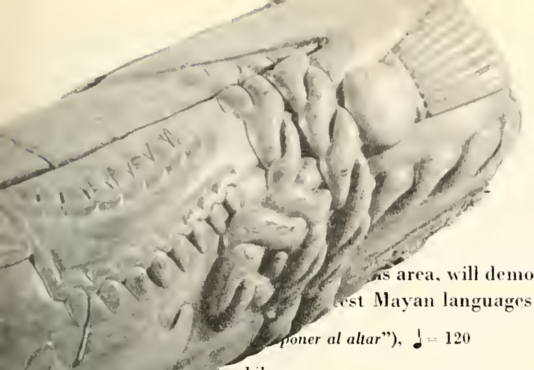
It is impossible to pinpoint a single instant in time as the precise moment when a new discipline is born, but most ethnomusicologists today speak of 1882 as the date of the formal beginnings of their field. In that year Theodore Baker's doctoral dissertation for the University of Leipzig was published; it was titled *Über die Musik der Nordamerikanishchen Wilden* ("On the Music of North American Savages"). In this book, Baker pulled together the written sources available to him; he had also talked with Indians (especially the Seneca), listened to their songs, and notated their melodies as accurately as he could by ear. So far as I know, Baker never wrote on this subject again, but with his work, ethnomusicology had formally begun.

The earliest name for the field was apparently bestowed upon it by Guido Adler in 1885; he spoke of it as *vergleichende Musikwissenschaft,* or "comparative musicology," which, he added, "has as its task the comparison of the musical works—especially the folksongs—of the various peoples of the earth for ethnographical purposes, and the classification of them according to their various forms."

In succeeding years, comparative musicology gathered momentum in Germany and in America. The famous Berlin Phonogramm-Archiv, one of the earliest depositories for recordings, was already in operation by the turn of this century, and by the 1930s, two learned societies devoted to comparative musicology had been founded, one in Germany and the other in the United States, but neither one lasted for more than a few years.

World War II provided a watershed for comparative musicology, and particularly the half-decade from 1950 to 1955 saw new and greatly heightened activity. In 1950 Jaap Kunst rechristened comparative musicology as "ethno-musicology" (the hyphen was soon dropped) in his booklet *Musicologica.* In December, 1952, the first stirrings of a new learned society were felt, and the Society for Ethnomusicology was formally established in November, 1955. Today it is a flourishing society with more than 1,500 members. And finally, in this same period a new group of young professionals completed doctorates and took their places in the field.

Despite Guido Adler's confident statement about the concerns of comparative musicology, ethnomusicologists today are sharply divided on the issue of what it is they ought to be doing. On the one hand are those, usually musicologically trained, who direct their attention to the sound of the music and its structure. On the other, are those, usually anthropologically trained, who prefer to view music as one human behavior among many, with a focus upon the human beings involved in it. These basic differences are multiplied in many ways. Musicologically trained ethnomusicolo-

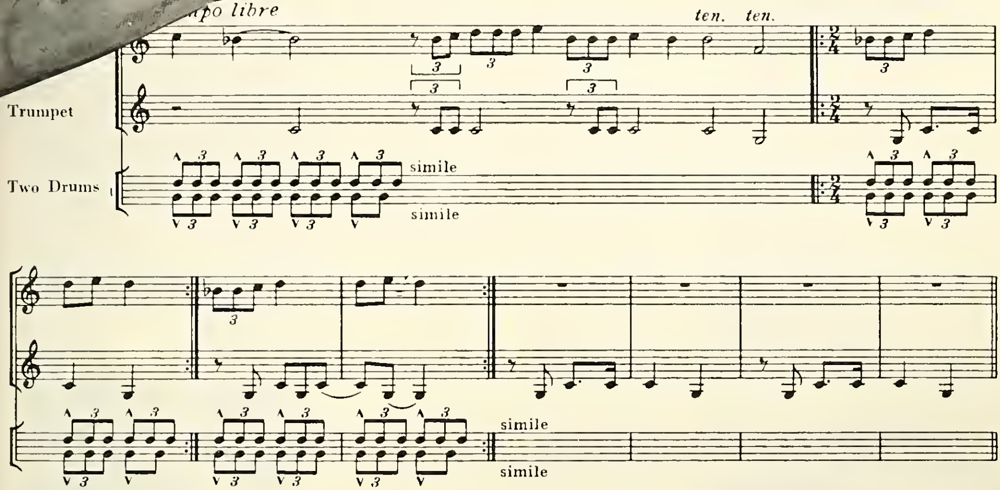


The teponaztli, *a horizontal wooden drum, is hollowed out to produce a resonance chamber and is beaten with sticks padded with rubber.*

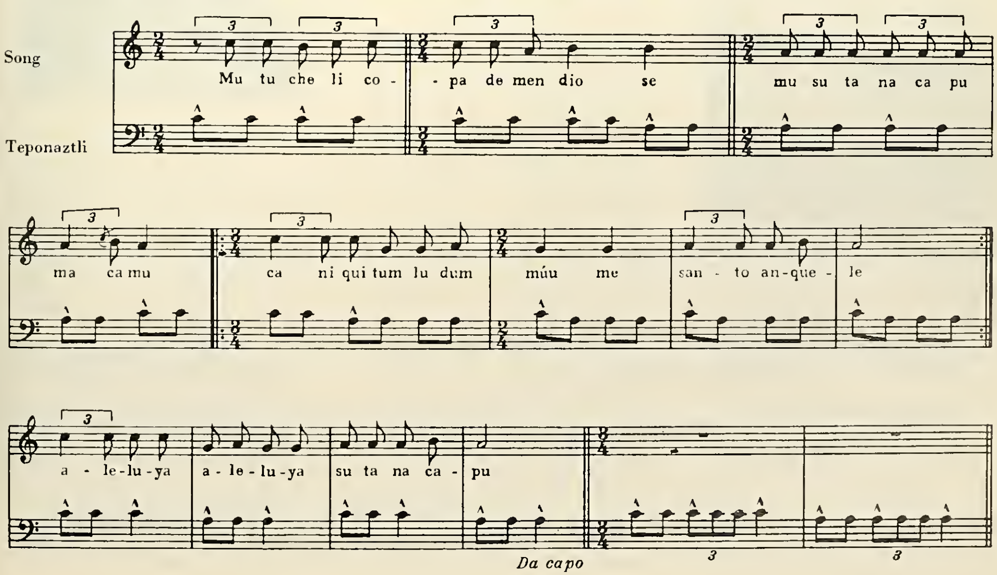
s area, will demonstrate the local vocal style. The text accompanying

est Mayan languages. The song is accompanied on the *teponaztli.*

poner al altar"), ♩ = 120


po libre
ten. ten.
Trumpet
Two Drums
simile
simile
simile
simile

Maya-Quiché (Chiapas). Ritual Song in the Chiapa Language, Nambarimu (B. Samper), ♩ = 76


Song
Teponaztli
Mu tu che li co-
-pa de men dio se
mu su ta na ca pu
ma ca mu
ca ni qui tum lu dum
múu me
san-to an-que-le
a-le-lu-ya
a-le-lu-ya
su ta na ca-pu
Da capo

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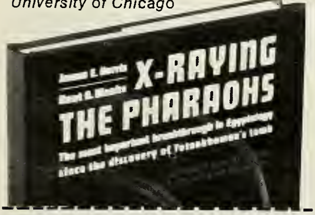
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gists tend to study the so-called fine art music of the so-called high cultures, for example, those of the Near and Far East; to stress the importance of learning to perform the music one studies; to empathize with that music and to emphasize its individuality; and to view the history of music as a value in itself. Anthropologically trained ethnomusicologists tend to study the music of the "nonliterate" peoples; to stress, not the performance of music, but the communication of knowledge about it; to seek to fit knowledge about a particular music with other data; and thus to generalize, to seek trends, and to formulate theories, laws, and theories of theories. They view the history of music as important for what it can show about developmental regularities and for the light it can shed upon the present.

These contrasting foci have led to very different contemporary definitions of ethnomusicology. Those with a musicological orientation are likely to define it as "the study of non-Western music," while those with anthropological leanings tend toward such definitions as "the study of music in culture and society." The musicologist, then, sees music sound as his study object and divorces it conceptually from the context in which it flourishes; the anthropologist conceives of music as a totality that embraces sound, context, behavior, concepts and all other possible facets of human behavior and ideation that can be labeled "musical." And there the matter rests today. Those who wish to pursue the subject further should read Mantle Hood's book *The Ethnomusicologist* (McGraw-Hill, 1971) for the musicological viewpoint; Alan P. Merriam's *The Anthropology of Music* (Northwestern, 1964) for the anthropological position; and Bruno Nettl's *Theory and Method in Ethnomusicology* (Free Press, 1964) for an attempt at a general overview. Earnest readers are strongly advised to consult all three!

Whatever their theoretical orientation, ethnomusicologists agree that the old comparative musicology grew up hand in hand with the study of North American Indian ways of life. Early American

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scholars, such as Alice Fletcher, did field work with Indians, while German scholars recorded and notated the music of Indians who visited Europe in Wild West shows, and worked with early cylinder recordings received from such American anthropologists as Franz Boas. Thus, the early studies of comparative musicology and of North American Indian music involve much overlapping literature, and this mutual development has continued to the present, with fruitful results on both sides.

Therefore it is especially frustrating to have to report that the volume under review here, Paul Collaer's *Music of the Americas*, is in many ways a distinct disappointment, and in only one a clear-cut addition to our knowledge. Indeed, the book is something of a mystery, for we are given no explanation for its presence, no rationale for why these particular pieces of information were put together in this particular way at this particular point in time. The title is grandly misleading, for the content of the book concerns only the music of North and South American Indians and of the folk societies of Central America.

The book begins without preamble, and the first 24 pages (oversized and printed in small type) comprise a short general introduction followed by culture sketches of the societies noted above. The material, however, is extremely brief for the ground that must be covered, and the reader is frequently brought up short by the fact that various segments—even paragraphs—are written by different authors. From his general introductory paragraphs one soon learns that Paul Collaer is preoccupied with the speculative search for origins as well as with the spirited defense of the values and esthetic qualities of non-Western music. The tenor of his remarks is, frankly, old-fashioned. In her sketches of North American Indian cultures, Eva Lips indulges in value judgments and sweeping generalizations out of another era, referring to "peculiar customs," "low cultural level," "age-old beliefs," people who are supposedly "warlike by nature," or who "have a typical

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agriculturalist's mentality." Rolf Krusche, who wrote the material concerning the "high civilizations" of Central and South America, avoids this kind of statement, but his prose is dense and often difficult to follow. Eva Lips closes out the introduction with material on the remaining South American cultures.

The next fourteen pages are devoted to "Music of the Eskimo and Indians," and they, too, are fragmentary, old-fashioned, and sometimes misleading. The best segment is that written by Willard Rhodes on North American Indian music. Vicente T. Mendoza devotes most of his space on Mexican folk music to descriptions of music instruments, and Samuel Marti contributes a seven-line paragraph that repeats the old myth that American Indian music is always bound up with religion. Most of the material is the work of Paul Collaer and it is a mishmash of bits of information on the music of Eskimos and North and South American Indians, including some music transcriptions.

Whatever value the book has will be found in pages 48 through 174, for featured here are 97 photographs, drawings, and paintings of music instruments, musicians, and dancers. For North America, the emphasis is on the old: some prehistoric instruments, some marvelous paintings and drawings, and many documentary photographs of early music practice, including two rare shots of Eskimo "song battles." The illustrations for Mexico and South America are mostly of contemporary scenes, and the photographic quality falters somewhat, but they are still valuable to us. Each illustration is discussed on the facing page by various of the authors, including one each by Laura Boulton and William N. Fenton, who do not participate in the introduction. Included here are materials seldom seen otherwise, such as bullroarers, reed instruments from the Northwest Coast, South American trumpets, and many others.

This book is not a good example of what ethnomusicologists can do, and its price will exceed its utility for most of us. But the illustrations are worth a look; in some ways, peering out at us is the very face of music.

Alan P. Merriam, professor of anthropology at Indiana University, is a specialist in ethnomusicology and the study of the arts in anthropology.

THE LONG AFRICAN DAY, by Norman Myers. *The Macmillan Company, $25.00; 404 pp., illus.*

This is a very big book, thick as a ream of typing paper. Lavishly illustrated with the author's photographs, mainly black and whites but also a gorgeous 20-page color section, it looks—and is priced—like another coffee-table volume on African wildlife. However, it is not only, or even primarily, a picturebook. The text runs to more than 300,000 words, and probably includes more factual information on East African animals than all similar-looking books put together.

It is the statement of a man who spent more than a decade becoming hopelessly attached to the African wilds, who progressed from esthetic awareness of it—abundantly displayed in his photographs—to a passionate desire to save it. Many people appreciate what East Africa has to offer, a fair number are actively trying to conserve the wildlife, but few have made such a total commitment: Myers, an Englishman who originally came out as a magistrate (only to be Africanized), has joined his fate to that of East Africa by becoming a citizen of Kenya. To better comprehend the problems and to equip himself to campaign for conservation, he set out to earn a doctorate in conservation ecology. Lately he has been involved in a predator survey for the World Wildlife Fund. In writing *The Long African Day*, his campaign to preserve African fauna and flora is fairly launched.

The book is presented as a day's sojourn in the parks, looking at the animals and the multiplying problems that must be solved if they are to survive. It is divided into four major sections: early morning, midday, late afternoon, and night, with the photos arranged accordingly and carrying the theme. There are some unusual, as well as many beautiful, illustrations: Myers is particularly good at action se-

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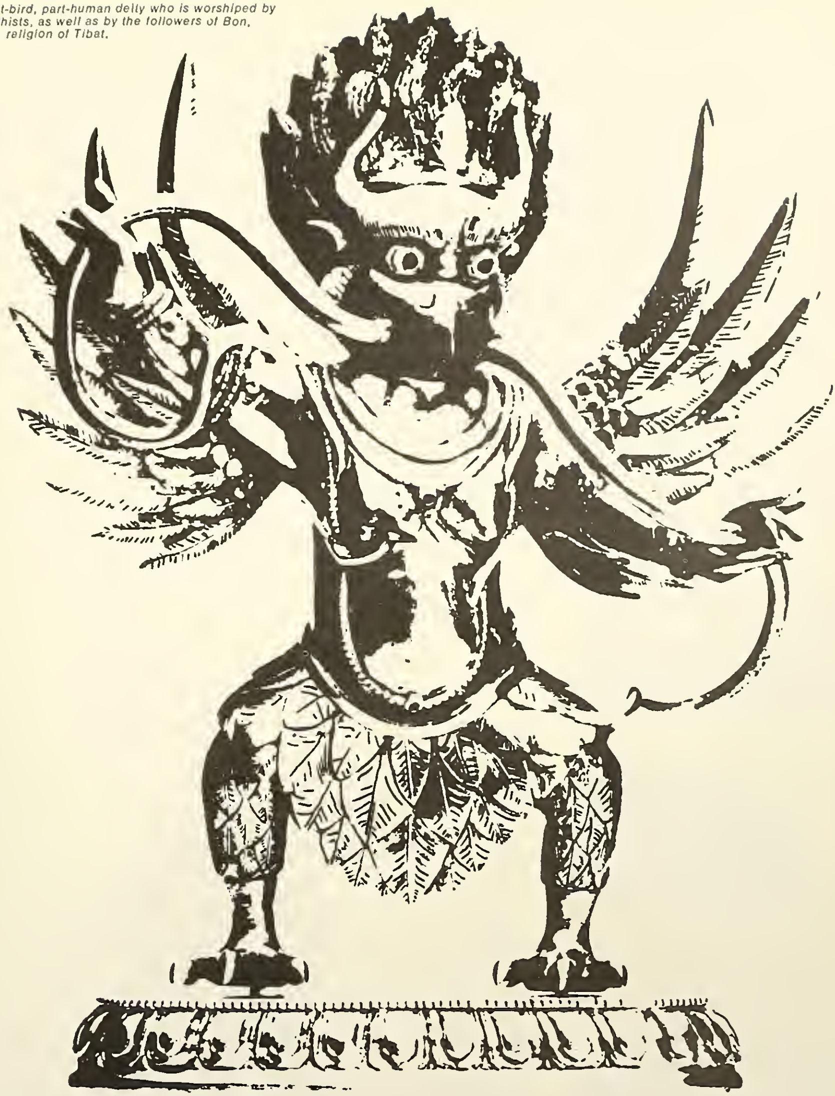
quences (lions catching and killing prey, for example), which entail long hours of watching and waiting. The *Long Day* also stands for the slice of geologic time during which recent African species have existed, and serves to make the point that the combination of Western technology and an exploding African population has in the span of half a century—the merest flicker of the eye on the evolutionary time scale—brought the long day of the matchless savanna fauna close to its end.

A large part of the book is devoted to animals prominent in savanna biomes: elephants, the species with the greatest impact next to man, hippos, giraffes, rhinos, zebras, wildebeest and other antelopes, the big cats, hyenas, wild dogs and other predators, the ubiquitous termites, and so on. Having observed and photographed these species himself, Myers could have written from his own experience. But he wisely avoids the anecdotal accounts of most authors of popular books of this genre, and draws instead on the results of recent scientific studies, thereby imparting much interesting information that has not previously come out in popular form. Once in a while he gets his facts unaccountably turned around, as when he makes the point that except for white rhino calves, young rhinos walk in front of their mothers (it is the other way around).

In every chapter Myers's concern with the future of these animals, which depends ultimately on preservation of their environment, is reiterated. As he points out, the parks with their wildlife cannot exist in a vacuum; they must be treated within the framework of the economic and social development of the African nations. He has therefore included essays on the pastoral Masai and ranching schemes for Masailand, on East African population trends and resultant pressure on marginal lands, on the pros and cons of increasing tourism, the economic feasibility of game cropping and game ranching, and the ecological viability of the national parks.

In sum, practically all the different factors that bear on the question of conserving African wildlife are laid out for the reader's consideration, and he is invited to draw his own conclusions. This may be



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difficult, because the author throws out a barrage of questions, few of which are answerable at present. If I have interpreted him correctly, these are his main conclusions:

Wildlife outside the national parks is doomed unless clear economic reasons can be found for keeping land unsettled and uncultivated. The irony is that the array of indigenous herbivores is demonstrably far more productive than man's domestic stock on the semiarid savanna and bushlands that make up most of Africa; yet game-cropping schemes have not been given a fair trial in East Africa. Squabbling between conservationists with purist and pragmatic approaches is largely to blame.

There is hardly one national park that is a viable ecological unit. Wildlife is increasingly concentrated in the parks as the lands around them become settled, leading to serious habitat deterioration and transformation, especially through the synergistic agencies of elephant and fire. Tsavo National Park is a classic example. To prevent this destruction, parks will have to be actively managed to keep wildlife populations in balance with available resources. The ideal of natural, self-regulating ecosystems is unrealizable within the parks as presently constituted.

The economic benefits of tourism, now Kenya's leading industry, are a strong incentive to preserve the parks and even to create new ones, but maintaining them is a heavy burden on the East African nations, which are receiving relatively little financial help from overseas, despite the oft-repeated assertion that African wildlife is a world heritage. Individuals, as well as governments, bear a responsibility to future generations and can materially affect the preservation of African wildlife by contributing money and moral support to international conservation societies and directly to the national parks.

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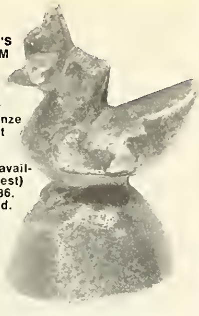

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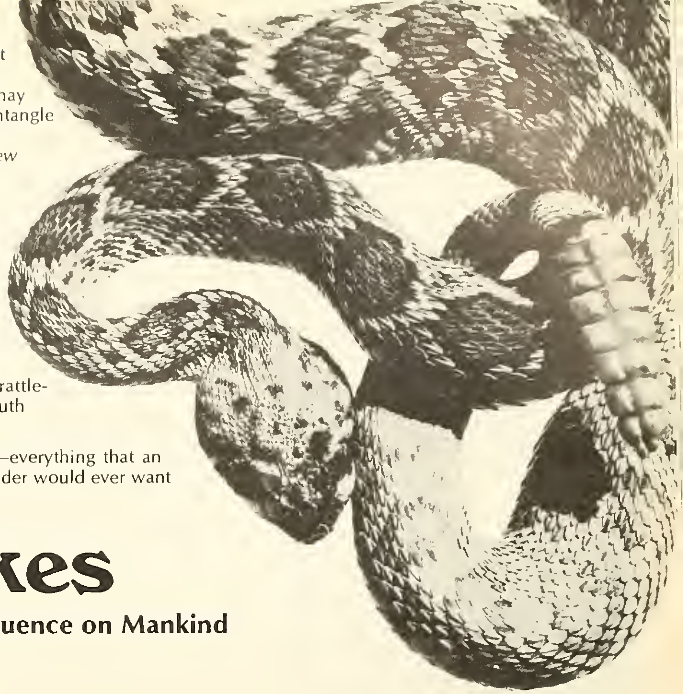

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Klauber begins by discussing the problems of classifying and identifying rattlesnakes. He includes keys to the rattlesnakes of various sections of the United States, Canada, Mexico, and Central and South America. (There are no rattlers in the Old World.) The text is supplemented by tables of geographical distribution, and numerous diagrams and photographs which are indispensable aids to identification.

Sections three and four discuss the paleontology, phylogeny and morphology of rattlesnakes. The former chapter examines the ancient history of rattlers through evidence left from fossil remains, while the latter is a treatise on the evolution of snakes.

Following this, Klauber deals with the behavior of rattlers. First he studies the physiological factors such as climate, altitude, and temperature mechanisms, including variations among the various types of rattlesnakes. Habitat, food, population and reproduction are also discussed at great length and any variables from species to species are noted.

Volume two concentrates on rattlers and their relation to man. It is here that Klauber compiles all the known information about rattlesnake venom, the bite, its effects, treatment and prevention. Again he discusses in detail everything from the structure of the fang itself and chemical composition of the venom to symptomatic case reports by species, and recommended procedure for treatment from both the physician's and novice's point of view.

Next Klauber surveys the problems involved in control and utilization of rattlesnakes, including economic feasibility and natural predators.

Finally the author relates various myths that have developed concerning rattlers—not only in our society but among the American Indians. This section clears up many widely held misconceptions about rattlesnakes.

Although not intended as a "popular" natural history, the lucid style, skillful avoidance of unnecessary technical jargon, and the fascinating subject appeal to readers with varying interest levels.

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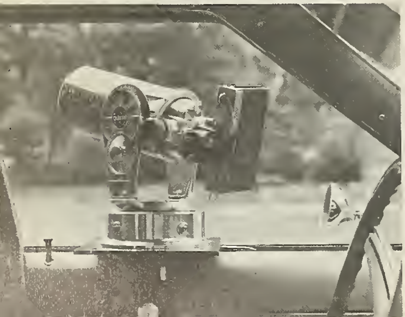

ing national parks must be made more tangible to the Africans from whom the lands, in many cases, have been expropriated. To overcome their understandable opposition to such sanctuaries, they should be given a percentage of the admission fees and/or allowed to benefit from surplus game stocks in in a legal, controlled way instead of by poaching.

The ecological nub of the matter is that there is a natural annual wildlife surplus that cannot be absorbed into a fully occupied ecosystem. If it is not utilized by predators, man included, surplus offspring not only go to waste, but also make for a reduced carrying capacity and higher mortality before being weeded out by malnutrition and disease. Thus, the key to conservation is utilization of the tremendous natural productivity of the savanna ecosystem for the benefit of man, so that the land- and meat-hungry African will want to reserve some areas for animals because he will see their value to him as a source of food and income.

The author writes informally and often forcefully, but not always clearly. He has a weakness for turning pat phrases ("piped water supports only pipe dreams"; "Ruaha Park may have a different future if the future has a Ruaha Park"). Probably he could have made his case more effectively if he had used fewer words and weeded out irrelevant details and questions. But Myers is not really to blame. These faults could have been easily corrected by good editing, but few publishers seem to offer this essential service any more.

Nevertheless, as the most complete and authoritative popular treatment of East African wildlife ecology, *The Long African Day* is a very valuable book, packed with information and beautifully illustrated.

RICHARD D. ESTES
Harvard University

THE WINDS OF MARA, by Colin Fletcher. *Alfred A. Knopf, Inc., $7.95; 384 pp., illus.*

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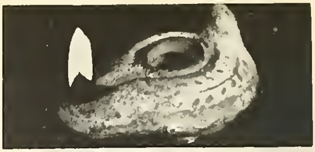

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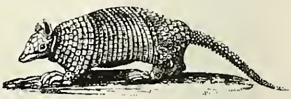

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ularly in recent times, rafts of writers have exploited the emotional response generated by the demise of the old ways and the endless game of Africa, and have lent it their sometimes haunting, but more often maudlin, last rites. One such epitaph echoes another, each lamenting, like a devotee of funerals, the fleet passage of time and the tragic decay of nobility.

Of course, it is all so true: the old ways, the thundering game herds, and the antique peoples are rapidly dying off and are not being replaced as they once would have been. Escalating human populations, land hunger, and the overt European hybridization of African customs and African instincts have affected almost all corners of what was once thought to be boundless country. Isak Dinesen was the first to describe this inexorable path of progress, and her lament, written nearly forty years ago, is still the freshest, the wisest, and the most ravishingly beautiful.

If Colin Fletcher had had his way, his book *The Winds of Mara* would not necessarily have suggested these winds of change. Originally intended to be a book about a natural ecological balance in Africa, it became, of its own will, a document of the fretful corruption of nature. The *Mara* of the title is short for the Masai-Mara Game Reserve, some 150 miles to the west of Nairobi, Kenya, and it is here that Mr. Fletcher discovers "harmony between animals and land, between men and land, between men and animals."

He is drawn to this flat platitude one night after watching an intricately veined leaf fall into the Keekorok Lodge swimming pool. Inside, at the bar are the tourists he is escorting through Kenya, and in the parking lot, his Volkswagen sightseeing bus stands ready to take him and his wards along the national park "milk run." Then and there he vows to return alone to the Mara to study its wildlife on different terms. Within a few weeks he is back in a rented "Roho," which he predictably christens "Rohosinante." His intention is to spend several weeks reconnoitering the country and the game, and then to return for an uninterrupted six months to study the wildlife.

The book is about this reconnaissance—a full month of concentrated game viewing, meticulous note taking, steadfast tea consumption, and continual negotiations with the Game Department and the Narok County Council. It seems that to write a book about the Mara one must make one's peace with everyone, within a hundred miles, entitled to a rubber stamp.

Fletcher writes about safari ants, cheetahs, wildebeest, elephants, and otters; he tells how it is to camp by oneself, dossing down next to the car after a warm Scotch, listening to the sounds of the night, ready to leave for more game viewing at first light. One of the goals of the trip is to visit "The Triangle," the remotest section of the Mara, which abuts on the Tanzanian border. But like many of the pleasures he anticipates, The Triangle, nearly devoid of game, is a disappointment. The first people he encounters there are sus-

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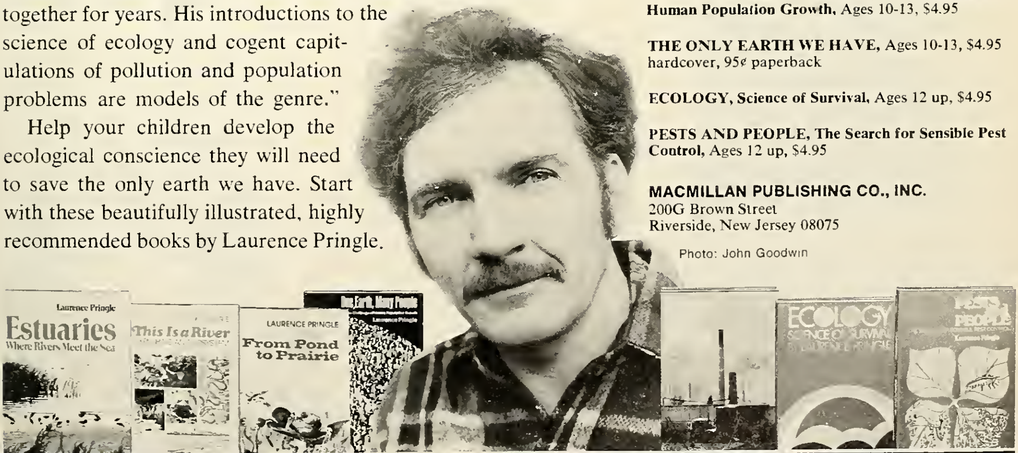

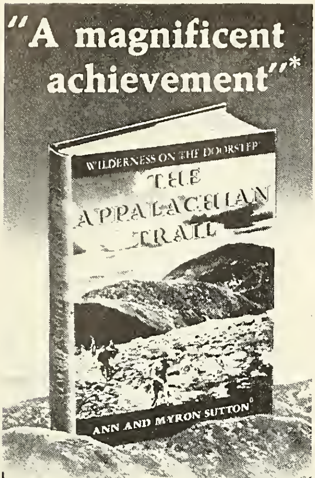

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pected poachers, and when he leaves, he does so, greatly disturbed.

The most enduring effect of *The Winds of Mara* is Fletcher's descriptions of the game rangers and the bureaucrats of Africa. The long waits, the endless failures of authorities to appear on schedule, the prevarication, the buck passing and, finally, the greed make the proposed six-month stay in the Mara unendurable. He stops making plans and leaves with bitter memories of a once harmonious place.

The Winds of Mara, fashioned to suggest that Africa has not lived up to its expectations, represents the broken shell of Fletcher's unfulfilled book. Who knows how that book, after six months of hard research, would have looked? This one, however, is not a success. Like all books lacking a destination, *The Winds of Mara* has been unnecessarily padded, stuffed up, with all kinds of nonessentials. Mr. Fletcher deserves every credit for unswerving honesty, but his honesty compels him to recount every mindless detail of the trip, leaching his narrative entirely of its poetry. Virtually every description is wordbound, and every thought, however mundane, is heralded by self-examination and followed by mental shock waves. Fletcher is not an endearing naturalist; almost all his observations are related to his earnest tea consumption and limited by the rectangular view from the window of his rude little car.

The Winds of Mara became for me a desperately sad book because its author offers no meaningful point to his story. Disturbed by what he has seen, bedeviled by his unfulfilled ambition to write a more substantial book, Fletcher concludes his narrative by boarding an aircraft. Leaving for home seems to be his only solution and it is perhaps this final surrender that makes *The Winds of Mara* everything that the spirit of Isak Dinesen militated against.

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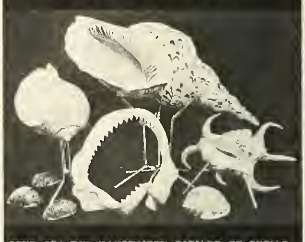

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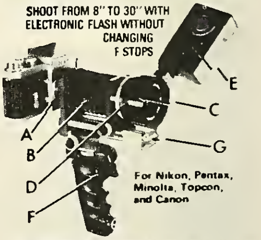

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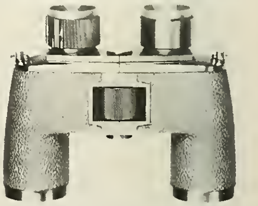

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Celestial Events

by Thomas D. Nicholson

The Sun and Moon As the sun continues to move north in the sky over earth, sunrise comes earlier and sunset later during April and May. At latitude 40° north, sunrise occurs at 5:23 A.M., local mean time in mid-April, and about a minute and a half earlier each day thereafter, until it occurs at 4:45 A.M. on May 15. Sunset, meanwhile, occurs at 6:38 P.M. on April 15 and 7:08 P.M. on May 15, or just about one minute later per day. Thus, the length of daylight in April and May increases about 2½ minutes daily, from 13 hours 15 minutes in mid-April to 14 hours 23 minutes in mid-May.

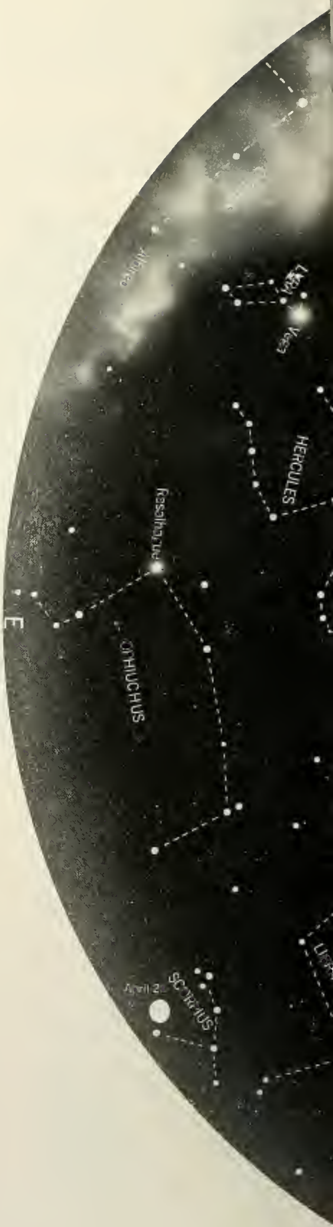
The waxing gibbous moon rises before sunset on April 15 and becomes the full moon on April 17. Thereafter, the moon rises after sunset, progressively later each night, wanes to last-quarter moon on April 25, to a morning sky crescent moon for four or five days following, then becomes new moon on May 2. The early crescent moon will appear in the evening sky by May 5. It will grow to first-quarter on May 9, when it sets about midnight, and to full moon on May 16, when it does not set until sunrise.

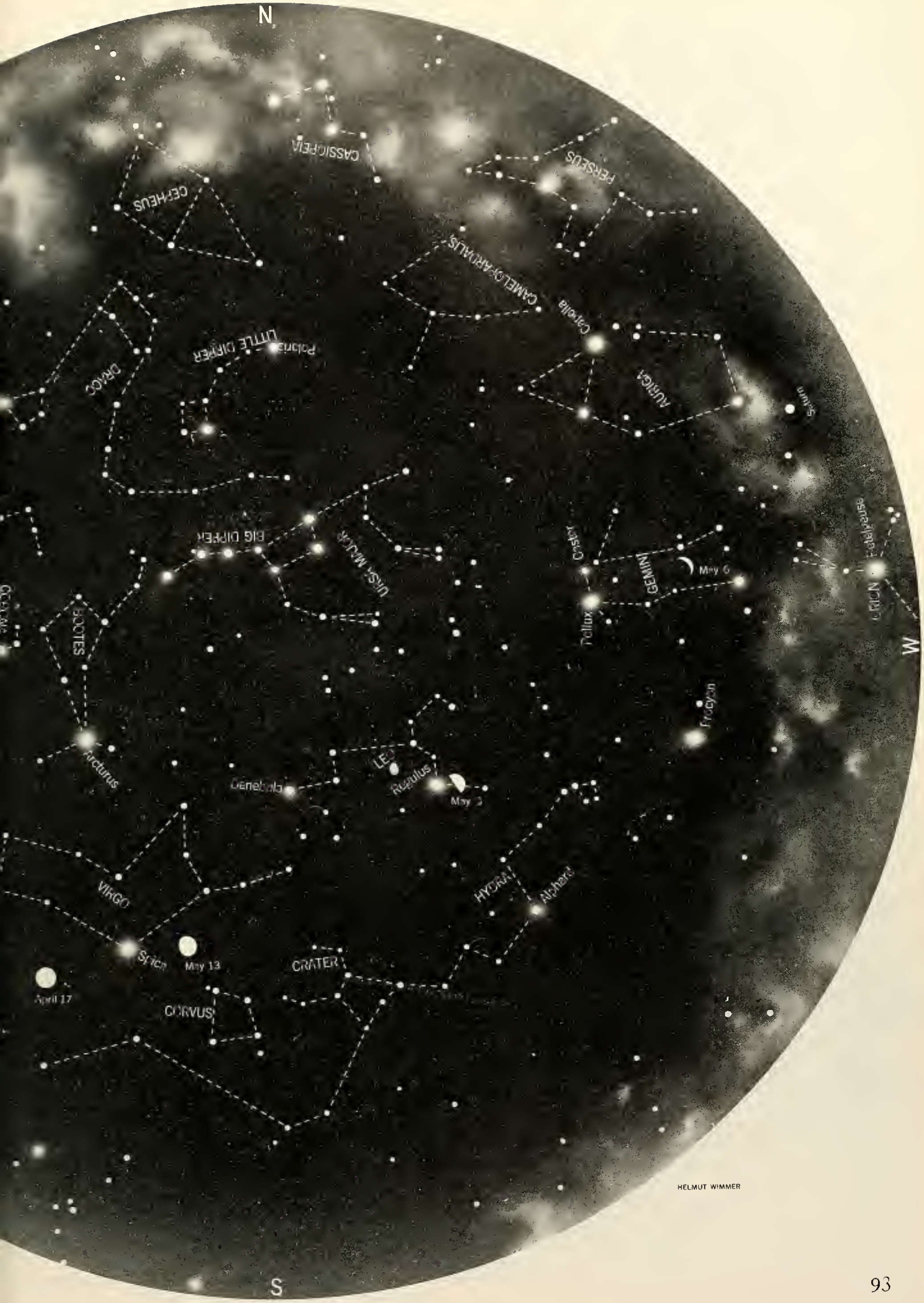
Stars and Planets Although it is in our sky every night, this season is the best to get acquainted with the Big Dipper, part of the constellation Ursa Major, the Great Bear, and the bright stars usually found by using it as a guide. Early in the evening, the Dipper is high in the north, almost directly overhead. The two stars at the end of its bowl are the Pointers. Pointing one way, out of the bowl, they lead to Polaris, the North Star, which is also the end of the Little Dipper's handle. Pointing the other way, they lead to Leo and its bright star Regulus. And the handle of the Big Dipper, three stars curving to the southeast, points to two bright stars along the extension of its curve: Arcturus, in Bootes and Spica, in Virgo.

April and May are poor months for evening planets this year. Only Saturn is present, in the southwest in Taurus each evening. The planet sets well before midnight, progressively earlier each night. Venus is also an evening star, but it sets within an hour of sunset. Morning skies are better for planets. Jupiter, in Capricornus, rises after midnight; Mars, moving into Aquarius, rises somewhat later. Both planets are well up in the southeast at dawn, Jupiter by far the brighter.

April 21: The moon is at apogee, farthest from earth.
April 22: Maximum of the Lyrid meteor shower occurs, but a waning gibbous moon will brighten morning skies.
April 26: Find Mars and Jupiter (the brighter of the two) near the crescent moon this morning.
May 1: Mercury and the moon are in conjunction.
May 4: The moon is at perigee, nearest earth.
May 5: The bright object to the right of the crescent moon this evening is Saturn, making its last appearance as an evening star this year. The weak meteor shower known as the Eta Aquarids, from the location of its radiant in the constellation Aquarius, reaches maximum, with no moonlight to interfere with morning observations. Although it averages only about 20 meteors per hour this morning, many will be swift and bright.

★ Hold the Star Map so the direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:20 P.M. on April 15; 9:25 P.M. on April 30; and 8:25 P.M. on May 15; but it can be used for about an hour before and after these times.

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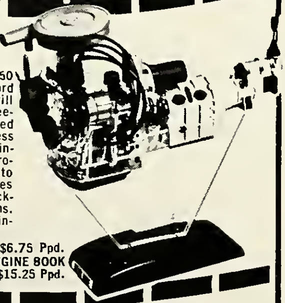

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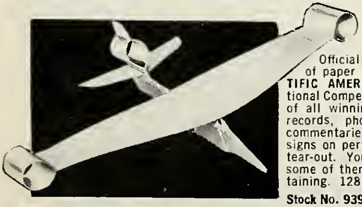

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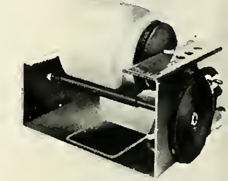

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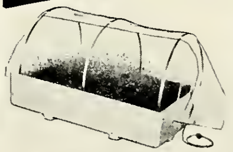

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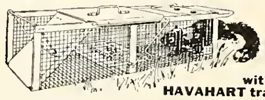

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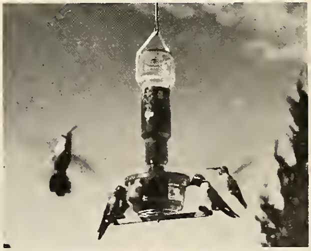

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Cover: *Two to three weeks after hatching, these prairie falcon chicks are gaining maturity on a steady diet of ground squirrels, plus an occasional small bird. In approximately four more weeks they will begin their first flights from the aerie. Photograph by Ron Austin, National Audubon Society. Story on page 66.*

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Natural History *incorporating* Nature Magazine *is indexed in* Reader's Guide to Periodical Literature.

Authors

An enthusiasm for street art led **Robert Sommer** to the sidewalk discoveries he describes in this issue. Sommer, who received a Ph.D. in psychology from the University of Kansas in 1956, is professor of psychology and lecturer in environmental studies at the University of California at Davis. In the past he has written for *Natural History* on such diverse subjects as zoos, time, and people's art. An avid photographer and bicyclist, he is presently working with a team of engineers to develop specifications for bicycle paths.

Robert Sommer

At the age of seven, **Thomas C. Barr, Jr.** was taken on a visit to Mammoth Cave and a career in the ecology and evolution of cave fauna was born. A professor of biology at the University of Kentucky, he has since explored more than 2,500 caves in the United States. His work in this area is his primary research interest, but he is also studying the ecology and systematics of ground beetles in the southern Appalachian Mountains. Barr, who has served as president of the National Speleological Society, is the author of *Caves of Tennessee.*

Thomas C. Barr, Jr.

Jørgen Meldgaard

Jørgen Meldgaard, who holds a degree in Nordic archeology from the University of Copenhagen, is a curator of the Danish National Museum. His special interests are the Viking record in the north and Eskimo art and archeology. He has

Visiting New York City several years ago and hearing that the air quality for the day was "unacceptable," **Theodore Crane** began to think about the long history of man in an urban environment. He spent the next two years studying classical texts and reconstructing from scattered references an idea of the quality of life in ancient Rome. Chairman of the Classical Studies Program at the University of South Carolina, Crane is currently using a computer to analyze Latin epic poems and plans to compile—also with the aid of a computer—a dictionary of proper names in Virgil and Lucan.

spent seven summers in Greenland excavating the sites of medieval Viking colonies. Among his finds are the location of a church built for the wife of Eric the Red—the first church built in the New World—and the graves of the men who colonized Greenland.

Theodore Crane

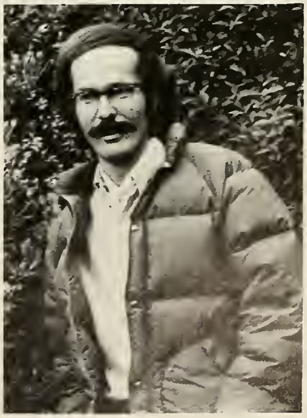
A technical writer and analyst, **Henry G. DeYoung** is presently with the IIT Research Institute in Chicago. A natural interest in wildlife conservation led to his concern with the fate of the bison in Yellowstone National Park. He believes that the proposed bison control program is "indicative of the presence, in high governmental places, of a strange and distorted set of priorities which bear close watching." DeYoung is also currently involved in the development of methods to monitor the flow of pollution in natural waterways.

Henry G. DeYoung

Eric Kroll

While on his way to Guatemala to compile a pictorial essay on Indians, New York-based, free-lance photographer **Eric Kroll** stopped over in Santa Fe, New Mexico. The interruption of his journey proved fruitful, for he soon discovered a photographer's delight: the Chicano murals that add abundant color to the local scene. In 1971, Kroll, whose work has appeared in a number of magazines, organized a portion of an Italian television documentary on the southwestern United States. His current project involves photographing the American Indians of the east coast.

When **Alan Pistorius** and his wife learned that a prairie falcon aerie near their home in the San Francisco Bay area was being robbed by falconers year after year, they decided to mount their own conservation effort. They appointed themselves guardians of the aerie and spent many hours in a tent perched atop a windswept cliff overlooking the nest site. Pistorius first became interested in birds as a youngster, and his concern over the precarious existence of most birds of prey has involved him in a number of other protective campaigns. He is now completing his doctoral work in English at the University of California at Berkeley.



Alan Pistorius

Letters

Prolonging Life

Would Dr. Bernard L. Strehler ("A New Age for Aging," February, 1973) be surprised if most people would say "no, thank you" to prolonging their lives?

What of those of us with no special mission or fascinating project to keep us alive in our minds and hearts? Most of us go through life grateful not to go insane from life's pressures—you would have us prolong that?

Those of you in science only see your own side of an issue, forgetting what it will mean to an average human or his world.

Mary Kotzen
Hewlett, New York

Sure I'd like to live for 20,000 years. It would certainly be interesting and perhaps fun. I am all for it from the personal, selfish viewpoint.

Yet I am totally opposed to the idea of a long-term moratorium on deaths, such as suggested by Dr. Strehler, for the simple reason that he proposes no corresponding moratorium on births. I am quite willing to grant that within 10 or 20 years it might be technologically possible to prolong the average life-span of individuals by a significant amount. But is Dr. Strehler willing to promise *me* that there will be a corresponding decline in the birthrate? The life-supporting capability of our planet is finite and is presently being strained. I am deeply troubled by what is implied in this article. Here is yet another example of a proposed technological tinkering with a not-too-well-balanced ecological system.

H. F. Gutgasz
Yorktown Heights, New York

If these efforts to further prolong life meet with success, what of our present (at least in England) overcrowded geriatric hospital wards? Are they to be eventually populated with 100- to 150-year-old patients, often discarded and dumped like last season's rotting cabbage stalks, visited by expectant relatives frustrated by their delayed inheritance?

Surely, we ought to at least devote an equal amount of study to the basic social problems that will inevitably occur if we older folk retain (along with our faculties) our professions, and let's face it, our sometime intolerance of the younger generation.

Allan Wright
Cheshire, England

Wolves vs. Hunters

In reply to the response of the delegate general of Quebec about his province's extermination program for wolves, I think Quebec is to be commended for having a more humane predator control program than some other areas. But I question why the hunting season for deer can't be eliminated—temporarily—instead of the predators such as wolves being eliminated. Is it really so imperative for man to be able to hunt deer? Couldn't we all make a temporary sacrifice so that the wolves can live too? A wolf's life is more important than indulging a man's desire to kill a deer. I pray that someday we will all value preserving wildlife over killing it.

Bonnie Germain
Naperville, Illinois

Cover Girl

Your cover of the February issue is the most interesting study I have seen in many years. The expression on the girl's face seems to express so many things—contentment, dignity despite the mud, pride of being, faint amusement at the idea the photographer wants such a picture, etc. Wonderful.

M. G. Mastin
Stamford, Connecticut

Developer Ads

I find disturbing, blood chilling in fact, the number of advertisements in your magazine by organizations dedicated to the destruction of nature. There are six ads by land developers: the most loathsome is the two-page spread of "Beaches of Nosara." Why should *Natural History*, of all magazines, sponsor an ad dedicated to despoiling an unspoiled Costa Rican Pacific beach?

R. W. Strandtmann
Professor of Biology
Texas Tech University

How Green the Revolution?

While I read the Green Revolution articles by Marvin Harris with interest, I am dissatisfied with the general pessimism of these articles and with the general conclusion that it is all a hoax. What alternatives would Dr. Harris propose to the problem of overproduction of people and underproduction of food in the countries the Green Revolution is supposed to help?

There are many hazards to the miracle grains as well as to older varieties. Some degree of genetic uniformity is essential for modern agricultural practices. Yet this genetic uniformity has long been recognized as a weak point in agricultural production. The recent corn blight epidemic in the United States emphasized this to a wider audience.

Will the Green Revolution succeed? It is too early to say. Is the Green Revolution a hoax? In its motivation and its objectives, it is not. Has the Green Revolution been subject to individual and governmental manipulation? Doubtless. Perhaps it is this that has embittered Dr. Harris.

R. N. Campbell
Professor of Plant Pathology
University of California, Davis

New Death Styles

Thomas and Dixon's interesting article, "Cemetery Ecology" (March, 1973) leads us to consider a new type of death style. After death a person would be buried in a biodegradable coffin of recycled cardboard. The top of the coffin would contain a seed strip with a variety of flower and vegetable seeds. A shallow grave would, of

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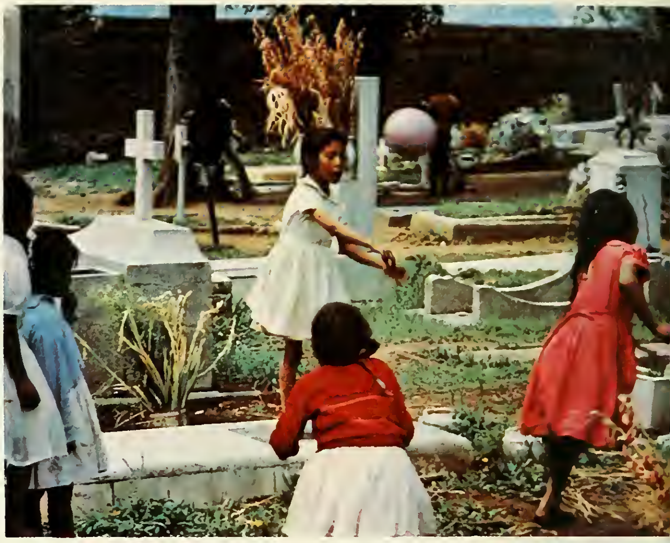

course, be required, but this type of decay would be more pleasant than the anaerobic decay characteristic of most human decomposition. After the flowers and vegetables matured, they would be harvested and a celebration of life from death would be staged. No longer would a funeral be a person's third greatest expense. And death would be celebrated as a necessity for new life.

William Elliott
William Kruczynski
Biology Department
Hartwick College

A few years ago we studied the health of a rural Mexican community. As shown in the enclosed photograph for Huixquilucan, the use of cemeteries for recreational purposes is apparently not limited to the lebensraum-restricted urban man. A graveyard has more to offer to the fertile imagination of a child than a paved ball court in the schoolyard, provided that the community's fears and superstitions do not lock the gates for him.

Mexican society places greater emphasis on children and motherhood than on the worship of the dead. It is therefore not surprising that the sounds of children at play, enjoyed during life, are not excluded from the dead. Furthermore, death in many Mexican communities is viewed less with macabre superstitions and more as an inevitable natural sequel to life. Thus, one is often struck by the use of bright colors in Mexican cemeteries.

Rjurik Golubjatnikov
University of Wisconsin
Center for Health Sciences

I for one am very glad to see attention being brought to the possibility of cemeteries as a source of wildlife preservation and limited recreational land utilization within the urban community. Perhaps people will be moved to request, if not demand, that the planners of cemeteries preserve and include as much "natural" area as possible. The planners can even revert to the rather archaic designs of winding roads, stone monuments, extensive plantings with marsh and water areas to attract more wildlife, rather than to leave in perpetuity the vast expanses of straight roads, close-clipped lawns, countersunk memorial plates, scattered holly bushes, and plastic flowers that have now become the economic fashion.

Stuart M. Fullerton
Curator of Natural Sciences
The Jacksonville Children's Museum

Good Advice

Re your message under the title "Unveiling the Black Widow" in the February issue: I *never* "idly sit down in an outhouse."

John E. Cunningham
Department of Physical Science
Western New Mexico University

For the physical and emotional health of your children, EXXON CORPORATION urges you to read this article from TV Guide—then discuss the idea with your school officials.

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CLASSROOM TV SHOW BANNED IN BOSTON

Not all instructional television is as dull as it used to be

On TV screens in thousands of classrooms this January, 8-to-10-year-old pupils will see a small drama about a little girl their age who loses her grandmother. Some of the action:

As relatives gather for the funeral, Linda and her cousins play in the family's front yard. One game is "Bang, bang, you're dead!" Linda gets "shot," falls to the ground and lies motionless a few moments, briefly alarming her playmates. Later her parents try to explain to her what it means to die. She asks them, "Are *you* going to die?" "Some day," her mother answers gravely. At the graveside, Linda hears the minister intone, "There is a time to live and a time to die."

Could be an episode of *As the World Turns*? Or *Edge of Night*?

Could be. But it's actually a 15-minute film produced by public-TV station KETC in St. Louis. It is part of a 30-episode educational TV series to be distributed in the U.S. and Canada by the National Instructional Television Center of Bloomington, Ind.

Classroom TV, often disparaged in academic and TV circles as a glittering promise that never got beyond mediocrity, is still around. It is, in fact, alive and well in many communities, and actually looking a little healthier.

It's a shoestring operation, to be sure, getting little aid from big government and philanthropic spenders, partly because Uncle Sam has never seen fit to make televised teaching a major funding beneficiary and partly because local school boards are too harried by rising educational costs to shell out much money for what seems to them a teaching frill.

Still, a few agencies like NIT are managing to crank out moderately successful contributions to a growing library of ETV materials. Founded in 1965 with Federal assistance, the center is now a self-supporting operation with nearly 700 hours of ETV programming available on a rental basis to the country's 210-or-so public-TV stations. Each year NIT assembles a consortium of underwriters to produce a new series of programs. The 31 participating sponsors include state departments of education, ETV networks and commissions, and Canada's Province of Ontario.

Costing a mere $600,000—roughly the amount a big commercial network spends for two runs of a prime-time movie—*Inside/Out*, as the forthcoming 30-episode series is called, is described by NIT as "the most extensive project ever undertaken in North American classroom television." (*Sesame Street* and *The Electric Company* are not in the same category because they are designed primarily for at-home rather than in-school viewing, although both are seen in many schools.)

Inside/Out is more ambitious than earlier NIT projects in several respects. Through little slice-of-life vignettes (such as one called "Must I/May I," picturing situations in which children struggle with their sense of responsibility), the programs will seek to provide a framework for classroom discussions of children's social, emotional and physical concerns. Months of research into schoolroom needs, according to Kent Owen, one of NIT's publications editors, found students and teachers "bored to death with blood and bones, things with no direct bearing on the children's lives," and crying out for ways to "feel through" children's inner feelings. *Inside/Out*, Owen believes, "is going to open up discussions in classrooms as they've never been opened up before. We're not dismissing the need for cognitive materials, but simply trying to deal with human feelings for a change."

The idea has brought educators running, the NIT official claims. "We didn't have to go out and twist arms on this one. The agencies and states came rushing in to participate." An unexpected windfall came from Exxon: a $200,000 grant to NIT to pay for printing and distribution of teacher guides and classroom aids.

Sample programs for the series have been field-tested in 10 localities, from Salem, Ore., and Fresno, Cal., to St. Louis, Chicago, Toronto and Boston. Altogether, 4000 children viewed five test shows.

The academic acceptance apparently has been exceptional. "We're flabbergasted at the enthusiastic response by the teachers," Owen reports. He admitted that some Boston schoolmarms had found the episode on death "inappropriate" and said they would not show it to their pupils. "Actually we're encouraged," the NIT man laughed, "to think we could produce something that would be 'banned in Boston'."

Assignments to produce shows for the series were parceled out by NIT to WNVT, the Northern Virginia Educational Television station in Annandale; WVIZ, the metropolitan Cleveland ETV station; the Kentucky Educational Television Network; St. Louis's KETC-TV; and the Ontario Educational Communications Authority. Dr. Orvis Harrelson, health-services director for the Tacoma, Wash., public schools, is serving as chief consultant.

The participating agencies have put up $450,000. NIT will try to get back the remaining $150,000 in fees from stations. Edwin Cohen, NIT's executive director, believes every public-TV station in the U.S. with daytime school service—a handful do not air such programming—will carry *Inside/Out*.

Is there some way NIT will have of gauging the classroom impact of the programs? "Oh, yes," Cohen reported. "The consortium members keep a close eye on how the programs are used in the classrooms and get back reports from teachers. You might say we have our own form of Nielsen ratings."

And NIT is confident, he implied, that *Inside/Out* is going to be ETV's 1973 hit show. END

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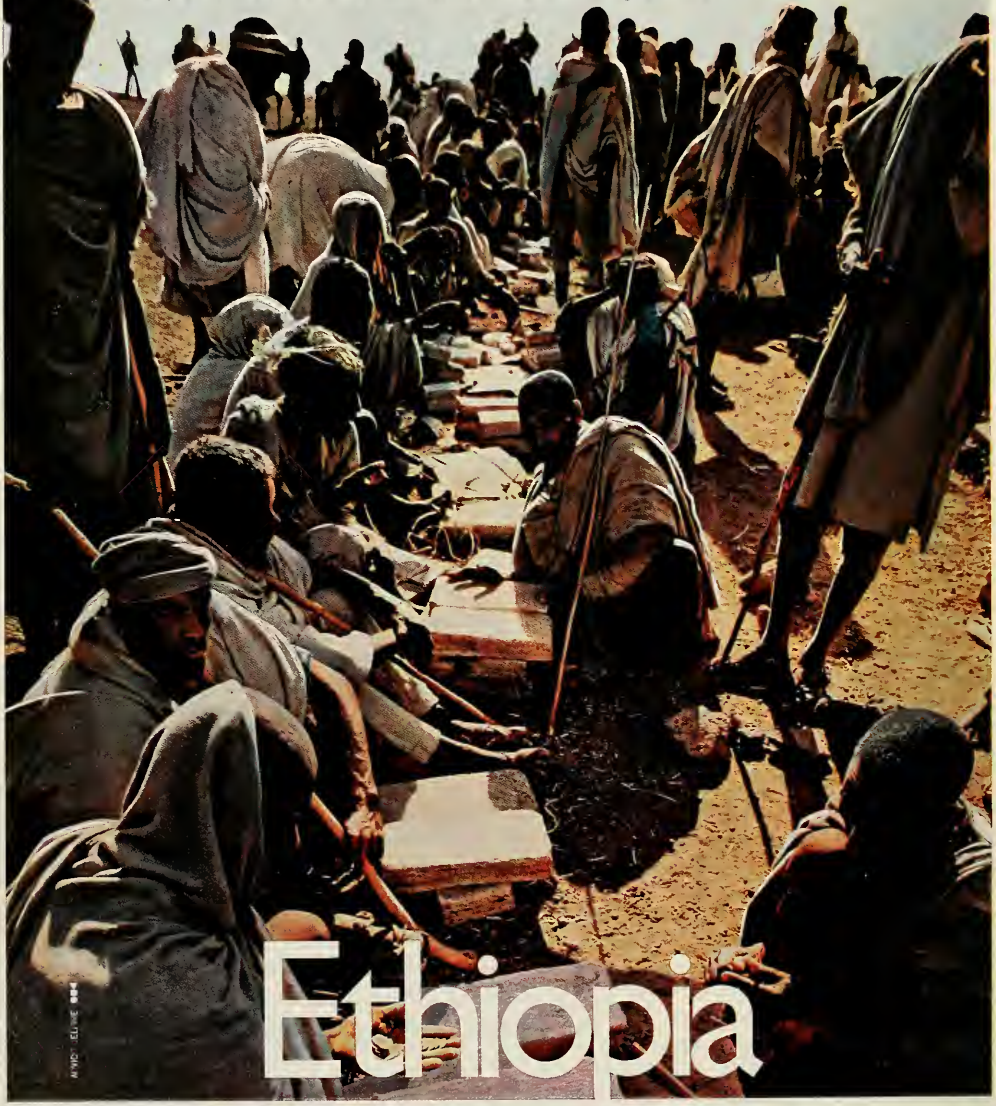

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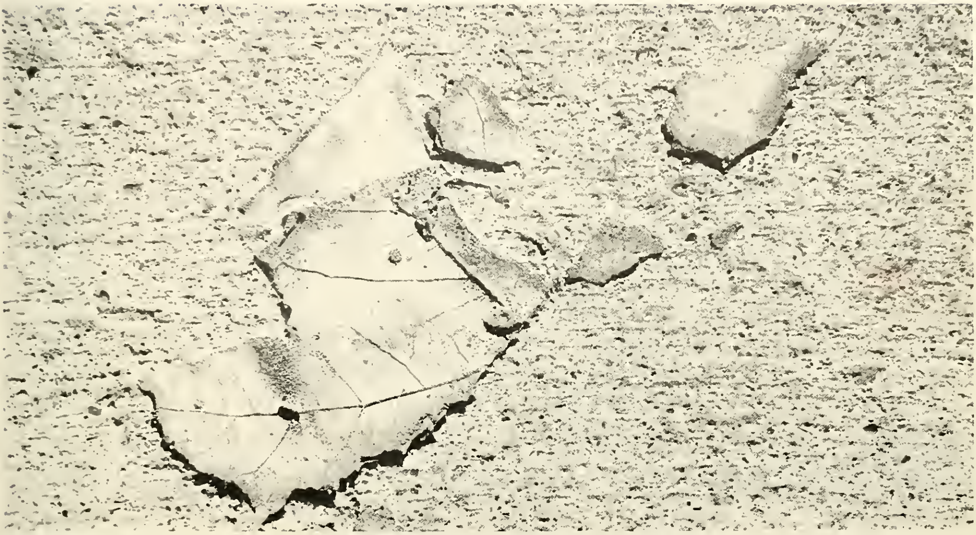
The Key to the Hidden Empire

Where Did You Go? Out.
What Did You Find? Fossils

by Robert Sommer



ROBERT SOMMER

For observant walkers, a record of nature as well as man is imprinted in the city

The sidewalk is the least appreciated element of the urban scene. Children become aware of every crack and change of texture as they play marbles and hopscotch, pitch pennies, ride bicycles, and roller skate through neighborhood streets. But adults use sidewalks simply as traffic arteries and look at them, if at all, mainly to see what to avoid—unmarked holes, lumps of chewing gum, dog droppings, piles of refuse, and broken glass.

Urban sidewalks, however, do contain pleasant as well as unpleasant surprises, as I learned while searching the streets of my own city, Davis, California. One day I came across the imprint of a leaf embedded in the walk. It was a genuine street "fossil" (I use the word loosely to mean a preserved impression or trace in stone of an animal or plant). That fortuitous occurrence alerted me to the unexpected richness lying underfoot in city streets and started me on a conscious hunt for fossilized imprints. I have found that people will find them only if they consciously seek them out.

Among other things, I have come across imprints of humans, animals, and plants. Some imprints were identity displays deliberately made by people seeking what they hope will be an easy immortality, but more interesting are the paw prints of dogs tempted by wet cement and the impressions of leaves and seed pods that fell before freshly poured cement had hardened. Another variety of fossil is created when twigs or small objects are mixed in with cement and hauled to a site. Eventually, these foreign objects wear away, leaving their outlines in the surrounding area. Long after the urban litter has been cleared away, these impressions will remain to intrigue future archeologists.

From human footprints, the observer can deduce much about the height, weight, and gender of the subject. Judging by size and pattern, I have concluded that most of the numerous footprints to be found were made by adolescent males.

Fossilized dog prints are also very common. Occasionally, one notices a spot where a dog has tentatively pawed the wet cement be-

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HARVEY OSHINSKY

A tourist outside Grauman's Chinese Theatre puts her hand in the handprint of a celebrity.

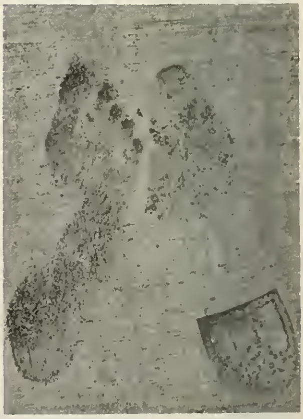
fore venturing across it. I have seldom seen a fossilized cat print, but cats don't often roam around city streets in daytime when sidewalks are being laid. It is also possible that felines, unlike canines and adolescents, are not attracted to wet cement. On rare occasions, I have found animal tracks that defy easy identification, leading me to speculate that someone in the neighborhood has an exotic pet, that a local poodle has been given an unusual pedicure, or that creatures not usually thought to inhabit the urban setting emerge from under the streets to use freshly poured cement as wallow pits.

When I first discovered urban impressions of twigs, leaves, and seed pods I was skeptical about how widespread they might be. But no longer—in the past few months I have found leaf and other plant imprints in every city I have sought them out: in Oakland, Berkeley, San Francisco, Sacramento, Dixon, and Woodland, in California, as well as in Niagara Falls, Ontario, and Hermosillo, Mexico. I am now convinced that such fossils are a general phenomenon. Some neighborhoods, of course, are more rewarding in this regard than others.

Experience has taught me which urban locations, and what kinds of paving, are likely to be the most promising hunting grounds for city fossils. Rough, mottled surfaces are poor places for imprints. Smooth, light-colored, new stretches of sidewalk, especially those laid beyond the business district in areas containing mature trees, are usually the most rewarding sections for finding fossil beds. Such places can best be spotted on foot. When I come upon one, I feel a run of excitement and an almost irresistible urge to explore every inch of the surrounding sidewalk. I usually carry a camera with me on these excursions, but recently my wife and I have begun to make street rubbings as well. Passersby, however, are not used to seeing adults down on all fours in a city street and we have startled pedestrians as well as drivers, who cannot imagine what we are doing.

While the finding of fossilized leaves around the base of a city tree is a satisfying experience, the finding of plant fossils where the plant life has disappeared is an experience of another order—it triggers the imagination. I have discovered impressions of leaves, for example, where there was no tree in sight. How many trees once lined the street, I wondered. How old were they? How tall? Why were they cut down? Was it Dutch elm

ROBERT SOMMER



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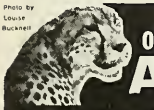

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disease, smog, or perhaps a street-widening program that sounded their death knell?

Because of the general hustle and bustle of urban life, the city is more often confronted than observed. But lack of awareness of street fossils may also be due to what psychologists call "the moon crater illusion"—an optical effect that causes figures to look either raised or recessed, depending upon the light source and the viewer's assumptions about the nature of the object viewed. Thus, in looking at a circle whose circumference is partially shaded in black, some viewers will see a hole, others will see a silo. Street fossils are good examples of the moon crater illusion, and since they can be seen as either raised or recessed, they are probably often mistaken for real leaves and fresh paw prints.

Some imprints can only be perceived under particular light conditions. For example, one winter morning in Niagara Falls, Ontario, my wife and I saw the remains of what we thought was a handprint, but it looked splotchy, incomplete, and disjointed. Later that day, we passed the same spot again and this time we saw all the details of the hand clearly outlined.

Among the human marks left in cement, some of the identity displays and territorial symbols must be considered vandalism, but most are examples of self-promotion rather than vandalism—they were made by building contractors and city agencies. In my neighborhood in Davis, one sidewalk contractor has inscribed his name four to ten times on some city blocks; every signature sprawls over 168 square inches of public sidewalk space. Another contractor has printed his name twice on each street corner, right side up and upside down, thus insuring that it will be legible to all passersby no matter in which direction they are walking.

Sidewalk fossils can only be created before newly poured cement sets. Because of this limitation, and because sidewalks are both largely ignored and subject to heavy erosion, most political reminders are written on walls. I did, however, come across one street inscription that sent my memory racing back in time: "Prisendent Kennedy Die the 22 of Nov. 1963."

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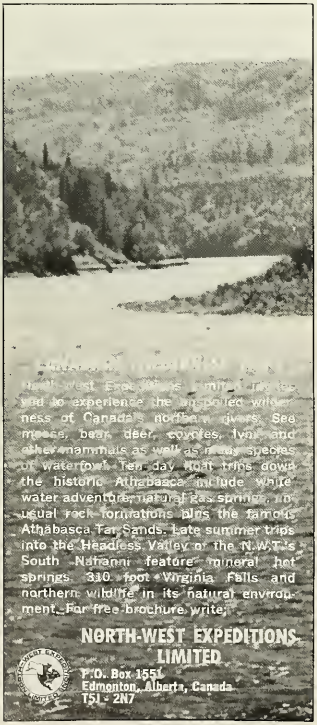
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Embedded sidewalk writing can help the urban historian reconstruct the city as it once was. Some sidewalks in the oldest sections of Davis still bear the printed date 1913. The next oldest date I found was a 1930s WPA marker. (During the depression the Work Projects Administration provided jobs for the unemployed.) Then there is a hiatus of about a decade, caused by the continuing economic slump and the advent of World War II, before an inscription of 1946 is found, marking the beginning of Davis' postwar street improvement program. Using these old dates and the former street names, history buffs can locate the sites of buildings that were demolished years ago.

Sidewalk writing can also help to identify the ethnic character of a neighborhood. The special script of the Chicano culture of East Los Angeles, rich in Mexican names and argot, is currently revealed in the sidewalk impressions of that section. In the housing tracts of southern California it has become a tradition to embed a child's handprint or footprint with a corresponding date in the cement of a freshly poured driveway. This practice was no doubt inspired by the proximity of Grauman's Chinese Theatre, whose sidewalk entrance contains the handprints and footprints of most of Hollywood's superstars. It is easy to imagine a team of archeology students two hundred years from now, armed with tape measures and calipers, examining the ruins of today's jerry-built tract developments for human prints, making plaster casts, and trying to reconstruct the culture they have come across.

ROBERT SOMMER

These paw prints, made by a large dog, were traced in a rubbing.

My investigation of urban fossils is really a personal search for the visual and tactual panorama of the city, for the richness of perceptual experience that is usually lost in the drabness, inhumanity, and general uglification of the current urban environment. Tuning out city streets has become part of a contagious fatalism about litter, sameness, and overcrowding. We city dwellers seek relief from man-made objects in the green spaces that remain inside and outside our communities. We flee to the countryside in search of flowers, mushrooms, jackrabbits, or shiny stones. We acquire houseplants, pets, or aquariums in a frantic effort to introduce natural elements into our synthetic environment. Another option, which should be explored with equal vigor, is to become aware of the urban setting at every level of sensory experience: to really see the city, feel it, hear it, and even smell it. We should not be slaves to a single standard of beauty, based all too often on dreams of unspoiled nature and pristine rural areas. Unspoiled nature hardly exists today, and many rural areas are, in fact, rapidly being developed into suburbs.

Last week my 12-year-old son found an amazing leaf fossil bed on the patio of a Davis restaurant. He was probably the first person to notice those botanic impressions and appreciate their clarity, symmetry, and beauty. Would he have had a more satisfying experience in the country? There is, of course, no guarantee that every walk through the city will lead inevitably to the finding of urban fossils. But if you look, you are certain to discover that city streets have their own magic. ■

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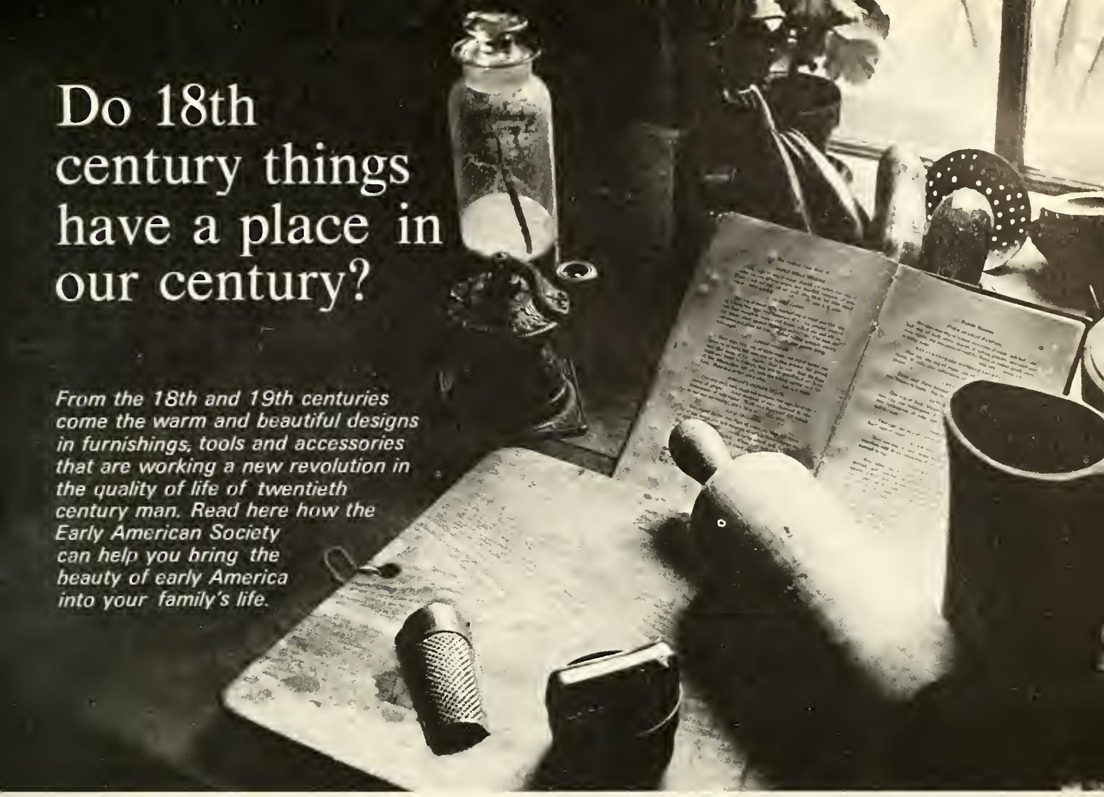

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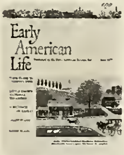

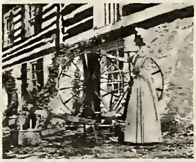

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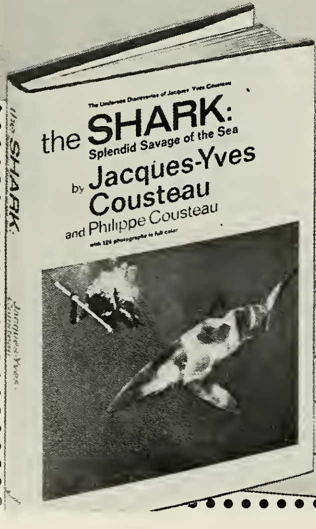
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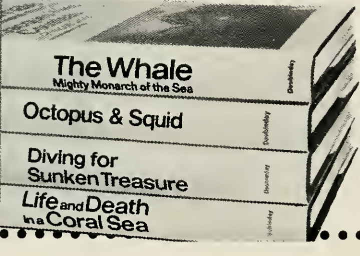
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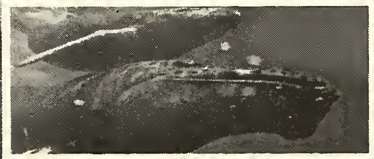

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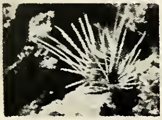

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The rapprochement between the United States and China has already led to several reciprocal visits of scientists and physicians, and the recent agreement negotiated by Henry Kissinger is certain to generate more traffic of this kind in the near future. Through such mutually beneficial interchanges, we should be able to learn much more than we now know about acupuncture, herbal medicine, and the efficient use of paramedical personnel, to name just a few areas of interest, while the Chinese should be able to catch up with many areas of our science and technology.

What about the possibility of scientific interchange with North Vietnam, from which we have been as culturally isolated as we formerly were from China? Were the Vietnamese able to sustain any substantial educational and scientific efforts while suffering through several decades of warfare against superior military powers and undergoing the most severe aerial bombardment in history? Our recent cease-fire and peacemaking moves with that country make these relevant questions. During a visit to Hanoi and environs in the spring of 1971, a colleague and I were astonished to find that educational and scientific activities had not only survived but were built into the daily war effort and had even flourished under adversity.

The Vietnamese have an ancient tradition of learning. For example, the former Quoc Tu Giam (or National) University, was founded in Hanoi in 1070—only seventeen years after the university in Bologna and fifty years before the one in Paris. Before it ceased to function as a university sometime during the nineteenth century, it had graduated more than 2,000 persons at the doctoral level in literature, history, philosophy, and mathematics. Today the institution serves as a museum.

In the DRVN (Democratic Republic of Vietnam), as North Vietnam prefers to be called, elementary education (from first through seventh grade) and nontechnical secondary education (seventh to tenth grade) are supervised by the Ministry of General Education. All DRVN children attend school through the fourth grade; about one-third go through the seventh grade, and one-tenth go through the tenth grade (from which 45,000 graduated last year).

When the French left in 1954, the French University in Hanoi (which they had established about eighty years before) was, with its 700 students, the only institute of higher learning in all of Indochina. Now, in the DRVN alone there are 37 colleges and universities, including the University of Hanoi (the "French" has been dropped), the Polytechnic Institute and its branches, and specialized colleges, accommodating a total of 75,000 students. There are also 150,000 students in vocational secondary schools (seventh to tenth grade) among the country's population of 21 million. The vocational schools and ten of the colleges and universities are supervised by the Ministry of Higher Education, which shares supervision of the remaining 27 institutions with production ministries, such as that of Agriculture. Almost all of the Ministry's staff of 200 have candidate's (equivalent to our master's) degrees.

In addition to his administrative duties, Ta Quang Buu, the dynamic Cambridge-educated Minister of Higher Education, still teaches mathematics at the University of Hanoi. Speaking excellent English, he told us that in terms of education the Vietnamese "are trying to do in 20 years what you Americans have done in 200 years." To some extent the Vietnamese are using both the Soviet and United States educational systems as models. However, Minister Buu feels that the Soviet system is too rigid and produces scientists whose training is too specialized, while the American system, although more practical in that it links science more efficiently to production, produces scientists whose scope is limited by their narrow political and social background. The DRVN is trying to evolve its own educational philosophy. As Minister Buu says, "We are in some sort of great Skinner box and trying to find reinforcement."

Students are selected for the universities by a competitive national matriculation examination given on one day each year (even at the height of the war), and candidates are screened to eliminate those with poor political records. Applicants choose an exam in one of three subject blocks.

The universities hope soon to begin graduate education on a formal basis. At present, 864 persons in the country hold either candidate's degrees or doctorates, earned mostly in other socialist countries. Vietnamese universities, however, recently awarded three candidate's degrees in biology—in fish breeding, cattle genetics, and ecology of estuarine vegetation—to students who largely devised their own courses of study.

Although women constitute only about 30 percent of the university student body, they make up 70 to 80 percent of those working in the fields of medicine and pharmacy. The Vietnamese are trying to further the participation of women in all of society, but the government considers those fields that require great patience to be more suitable for women than activities that demand great physical strength and endurance. This attitude persists despite the fact that much of the routine heavy agricultural labor in Vietnam is done by women. At present, the official opinion is that not enough women are involved in education—for instance, only 10 percent of the students studying abroad are women, and only two or three women hold university chairs,

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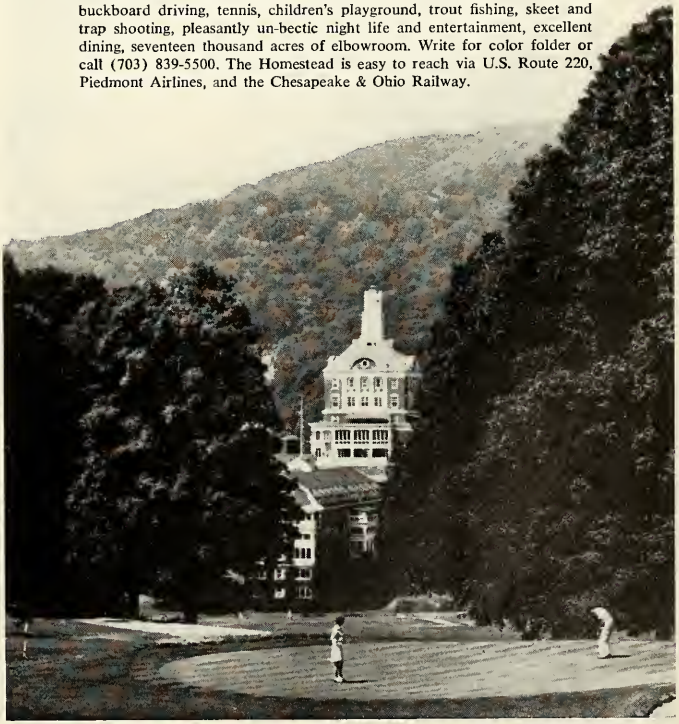

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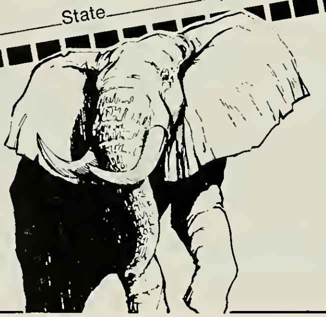

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that is, professorships with tenure. Therefore, like disadvantaged minority groups in the United States, women are given special tutoring to prepare them for higher education and their university entrance requirements are lowered. Scholarships, in the form of compensation to their families for loss of services at home and in the fields, are used to increase the number of women in secondary schools. "There is no freedom," said Minister Buu, "when there is no freedom of women."

As in Europe, institutions of higher learning are divided into faculties, each having at least one chair. The 37 colleges and universities have 529 chairs for 7,000 faculty members. Although the younger faculty members are dependent on the chair holders for guidance and advice, as in the European system, our interpreters said North Vietnam had more academic democracy because of its relative lack of hidebound traditions. New chairs are decided on jointly by the ministries and state committees on planning, science, and technology, with money being a prime consideration. Thus, a chair of mathematical engineering, which includes cybernetics and linguistics, was recently made possible at the Polytechnic Institute through the gift of a Soviet Minsk 22 computer (roughly equivalent to the IBM 704), whereas an equally needed research chair in biochemistry was turned down because it would require the purchase of expensive equipment like electron microscopes.

Classes at Hanoi's prewar French University were conducted in French. Now higher education is given entirely in the Vietnamese language; although the many ethnically distinct minorities use their own dialects in everyday affairs, they use Vietnamese as a second language. Russian is today the most commonly used foreign language with English second, although most of the older professors still speak French. Many of the textbooks, which formerly were translations, are now original material written in Vietnamese. Some Russian, English, and French books are also used.

The University of Hanoi has 500 faculty members and 3,500 students, of whom 20 percent are women. Whereas 80 percent of the population as a whole are peasants, the student body includes peasants, urban working people, and the offspring of professionals in a ratio of 60:15:25. After graduation, 10 percent of the students go into academic work, 30 percent go into industry or agriculture, and 60 percent go into school teaching. Some 1,200 of the ablest university graduates are now receiving advanced training in other socialist countries. About 75 to 80 percent of the students take the rigorous science curriculum.

The Polytechnic Institute is now housed primarily in a spacious modern building constructed with Soviet aid in 1965. It was founded in 1956 with 40 Vietnamese-educated teachers and 800 students. By 1965 there were 6,000 full-time students and 200 correspondence students. That year the Institute spawned four new engineering colleges, but retained the balance of the curriculum. Courses at the Institute emphasize technology; even those in the hard sciences are slanted more toward applied aspects than similar courses in the universities; for example, mathematics and physics are combined into a single department, thus applying most of the mathematics to physical problems, while chemistry is slanted mainly toward chemical engineering. The Institute currently has the same number of students it had in 1965, but the faculty has increased to more than 800. Of that number more than 100 have doctorates or candidate's degrees, and they devote an average of 30 percent of their time to research.

The Polytechnic's general educational policy is formulated by the government and the Communist Party. Scientific training aims at a combination of what is "most fundamental, most modern, and most Vietnamese." About 10 to 15 percent of the formal curriculum is set apart for courses, taught by a special staff, in the history and political aims of the Vietnamese Communist Party and in Marxist-Leninist philosophy. In addition, Thursday evenings are spent in discussion of "morals" and current events.

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a special second examination. By design, one-third of the entrants are women, and special consideration is also given to ethnic minorities and factory workers. Most students come from peasant and working-class families, some from South Vietnam. Each student is given a scholarship that includes meals and textbooks and lasts for the five years it takes to earn a professional engineering degree. Most graduates go into factories, although a few stay on for further training as teachers or researchers.

The Polytechnic maintains more than 50 laboratories and workshops designed to simulate factory conditions. Those facilities we visited were furnished with teaching equipment donated by the Soviet Union (some of which had been modified by students using electronic components salvaged from downed U.S. planes) and heavy machinery made in the Soviet Union, Czechoslovakia, and Haiphong. The 300,000-volume library, whose 76,000 journals are mostly in Russian and Chinese, seemed well designed and housed.

Because of the war, some educational institutions were dispersed in the countryside. Agricultural College Number 2, founded in 1967 at the height of the air attacks, is located about one and a half hours' drive from Hanoi. The 212-acre main campus, designed primarily for teaching, is a collection of small, temporary, bamboo-framed, thatch-roofed buildings that include classrooms, a library, laboratories, and dormitories, spaced among farm plots. A second campus 31 miles away has 741 acres of experimental farms. Both campuses have been bombed. To minimize damage from the air war, the buildings are set far apart, with air-raid trenches in between.

The college, which is supervised jointly by the Ministries of Higher Education and of Agriculture, trains students in three faculties: botany, zoology, and agricultural economics. About two-thirds of the college's 104 teachers belong to the Ho Chi Minh Labor Youth and many belong to the Communist Party, although neither is obligatory. There are 1,400 students, of whom one-third are women. The four-year course is planned to follow secondary school (tenth grade),

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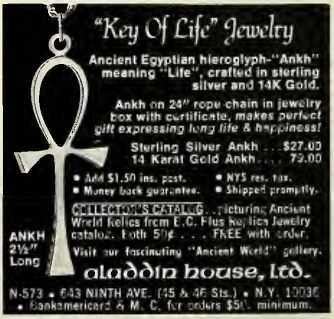

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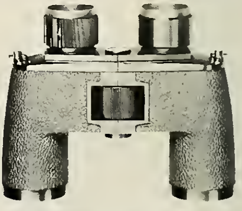

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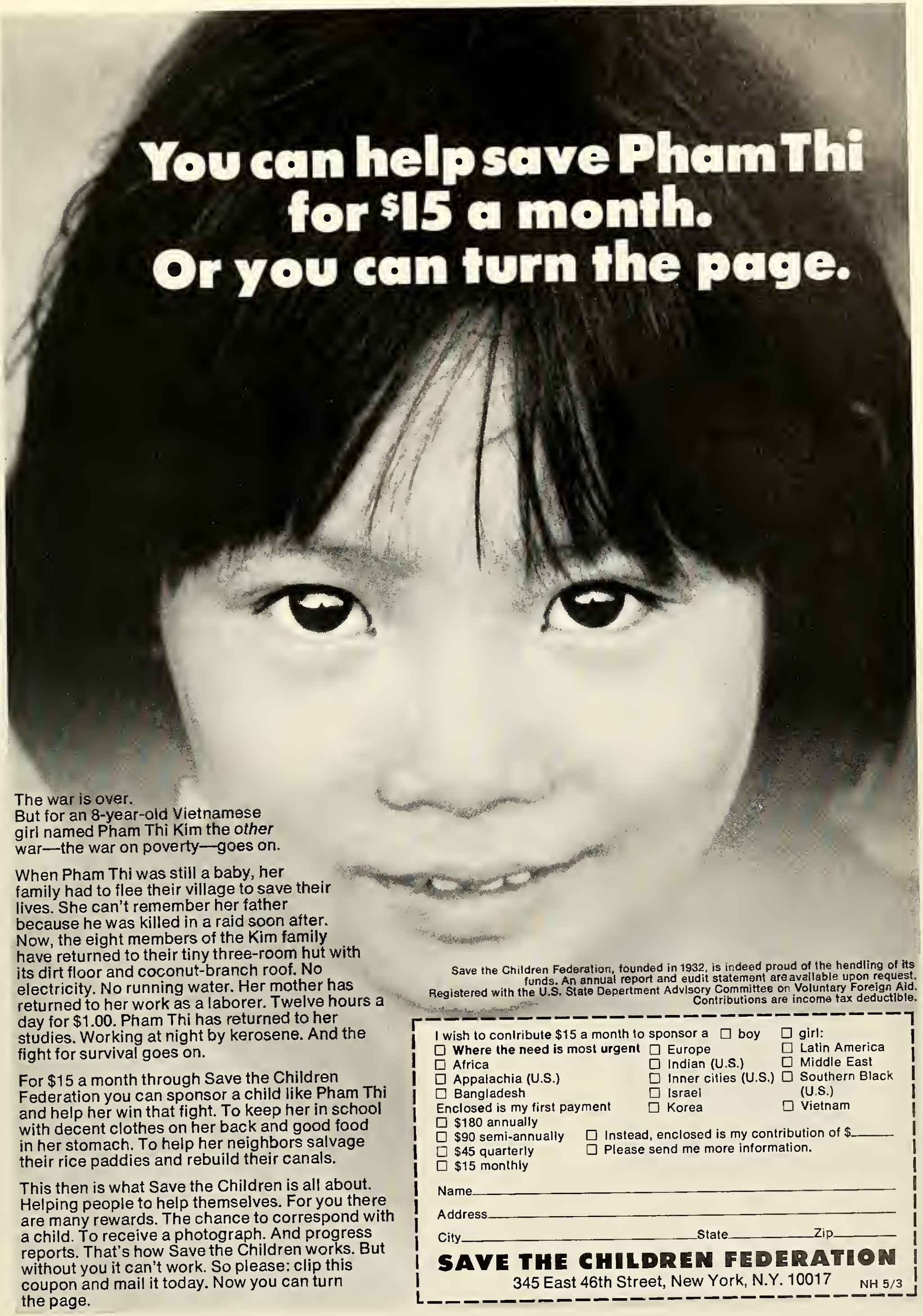

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but the college also runs a two-year "crash course" for seventh-grade graduates, and gives remedial courses for weak secondary-school graduates. College Number 2 graduated its first class in 1971. Most of its degree holders will work as technical cadres on agricultural cooperatives, state farms, or agricultural stations. In the future, some students may be trained as teachers.

While at college the future agriculturists live in dormitories and stay on campus. Classes run six days a week, with students free to be away only from 5:00 P.M. on Saturday until Sunday night. Half a day a week is spent in maintaining the grounds and fields. Students have private clubs where they may spend an hour a day at art and gymnastics, although the regular curriculum includes two hours a week of these activities. Formal study lasts thirty weeks a year; the rest of the time, except for two months' vacation, is spent at practical work.

There is a striking contrast between the modest bamboo-and-thatch farmhouselike exterior of the laboratories and the sophisticated modern equipment—microscopes, centrifuges, and electrophoresis apparatus—they contain. Classes are run in a traditionally formal way, with professors lecturing and students taking notes.

This improvised North Vietnamese educational system, forged during a revolution and tempered by several wars, has served the country well so far. Whether it can sustain the altered dynamics of peace is hard to predict. Perhaps Americans and other Westerners, through economic aid, can help shape some of the DRVN's new educational directions. And perhaps, if reciprocal scientific and educational exchanges follow the cease-fire, we may discover in this former enemy country new approaches and solutions to some of our own problems.

In a future column, I will describe the scientific research I saw being conducted in North Vietnam.

Columnist Arthur W. Galston teaches biology at Yale University. His book Daily Life in People's China *will be published in June by Thomas Y. Crowell Co. A more complete discussion of education and science in the DRVN is found in an article in* Science, *vol. 174, pp. 379-385. 1971.*

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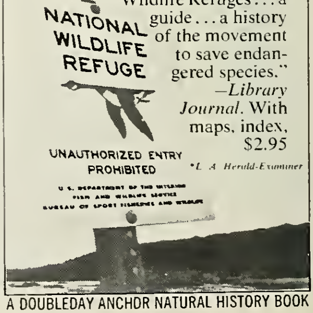

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Refugees of the Ice Age

When the glaciers retreated and North America became arid, some forest-dwelling insects and reptiles sought shelter in caves. Genetic alterations will keep them there

by Thomas C. Barr, Jr.

Because of its inherent simplicity, the life community of a cave holds a special attraction for ecologists. Unlike a tropical rain forest, a meadow, or even a farm pond, a cave is inhabited by a comparatively small number of animal species. In the eastern United States, caves usually contain between ten and twenty blind, cave-limited species. Although some may have as few as five or six, other, more richly diverse cave communities may have as many as forty such species.

Mammoth Cave in Kentucky is the best known of the rich cave communities, and biospeleologists have recorded about forty-five blind species among the more than 200 species of animals found in the system. One of the best places to study Mammoth Cave's terrestrial fauna is in White Cave, a small cave connected to Mammoth by narrow crevices impenetrable to man and rarely visited except by biospeleologists.

When a visiting Australian colleague wanted to see the famous Mammoth Cave fauna, it was only natural that I took him first to White Cave. As we climbed about, over, and finally through a long curtain of dripstone that slices diagonally across the cave, we saw here and there a small creature crawling rapidly over the wet rock. Farther in, the cave animals performed as if on cue, one species after another parading before the advancing circle of lantern light. My colleague noted that it would take twenty years to see that much life in the caves of Australia. The remark was a chance one, but it returned to puzzle me for months afterward. How does a community of cave animals arise in the first place, and why should there be such marked disparity between the communities of different cave systems?

Whatever the diversity, the fauna within a cave consists of unusual animals scuttling across wet rocks, swimming in dark rivers, or flying through echoing silence. These animals live in an environment without light, isolated from the surface yet dependent upon it, for there must be sufficient access to the surface for the animals to receive food, water, and air. Through an awareness of the behavior of cave animals, their adaptations to the cave environment, and the environment itself, answers to questions concerning cave fauna diversity can be more readily resolved.

Most cave communities include many troglobites, blind species with reduced pigmentation; a number of troglophiles, animals that can live out their lives equally well in caves or in cool, dark places above ground; and a few trogloxenes, animals that regularly utilize caves for shelter but return to the surface to feed. Of the animals recorded in Mammoth Cave, 22 percent are troglobites; 36 percent, troglophiles; 22 percent, trogloxenes; and 20 percent, "accidentals" that fell or were washed into the cave.

Trogloxenes are often indispensable to the energy budget of cave ecosystems. Bats and cave crickets, for example, which feed outside the caves at night, contribute large amounts of guano, and often even their own dead bodies, to the food web of the cave. Eyeless species of carabid beetles in both Texas and Kentucky have independently evolved the habit of feeding on eggs of cave crickets, which they dig out of the silt on cave ledges and floors.

Water, like food, also enters caves from the surface, the amount fluctuating seasonally. It either seeps downward from the soil through open joints in the limestone or flows underground as sinking streams, carrying food for the cave community in the form of bacteria, protozoans, other microorganisms, twigs, leaves, sticks, and even logs and larger animals.

In the southeastern United States, the driest time of the year underground is autumn. Transpiration of green plants removes vast quantities of soil water during the growing season, and the normal au-

Dixon Cave, a typical gallery of the Mammoth system, was probably the largest entrance to the system until it was cut off and isolated by an underground landslide.

THOMAS C. BARR, JR

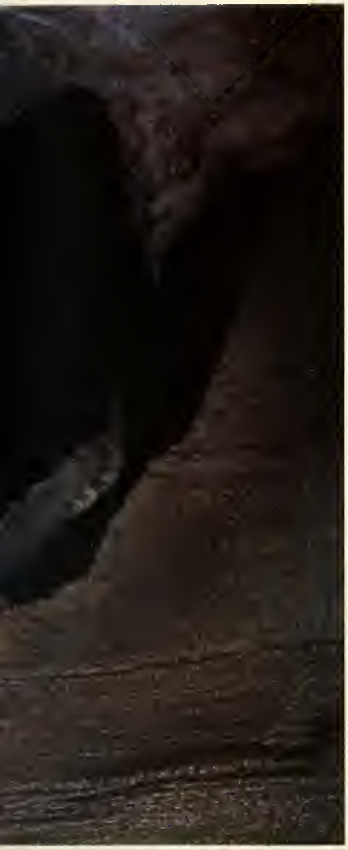
HOWARD N. SLOANE

tumn rains do not saturate the soil until early winter. The first heavy rains of mid-December or early January mark the beginning of the flood season in caves. Even in tropical caves there are usually seasonal floods corresponding to the rainy season at the surface. The food supply carried underground by water is thus concentrated during part of the year, rather than being spread out evenly.

Most large caves "breathe," pouring cooler air from their mouths in summer and sucking in cold, dry air from the outside in winter. This breathing effect is primarily the result of a density gradient between heavier, cooler air and lighter, warmer air. Cool, dry winter air is especially hazardous to troglobites, most of which have lost not only eyes and pigments but also the ability to regulate water loss through evaporation from their integuments.

I suspect that my interest in caves and cave life was first kindled on a tour of Mammoth Cave in the late 1930s. A stubbornly curious seven year old, I teetered precariously but persistently on a ledge at the end of the commercial trail, trying to penetrate the gloom of the chasm below by the dim, pulsating light of a hissing gasoline lantern. Ignominiously snatched from my vantage point by my horrified parents and the cave guides, I resolved that I would some day explore far beyond that chasm and a half dozen others that had roused my curiosity. Sixteen years and 500 caves later, it was no accident that the Mammoth Cave system assumed a role of central importance in my studies on cave invertebrates.

The principal cave area of Mammoth Cave National Park lies beneath three sandstone-capped ridges, which are separated by blind valleys, a feature in karst areas formed from the coalescence of many sinkholes. The older and best-known cave passages are in Mammoth Cave Ridge, but extensive cavern development exists beneath Joppa Ridge to the west and especially beneath Flint Ridge to the east. The rock strata are gently tilted to the northwest toward the 300-foot-deep canyon of the Green River, which meanders across the park from east to west. Ancient subterranean streams have carved out five or six successive levels of



passages. The cave rivers carry water from the streamless sinkhole plain outside the park and eventually empty into the Green River as large springs. Between the sinkhole plain and the Green River, these streams flow through the lowest levels of an incredible maze of passages whose total length makes Mammoth Cave the world's longest known cave system.

In the "Xanadu" of Coleridge's poem "Kubla Khan," the sacred river Alph ran "through caverns measureless to man." In the intricate complexities of Mammoth Cave we can appreciate the poetic similarity. For many years the "traditional" length of the cave was 150 miles, but the prosaic objectivity of the measuring tape indicated that as of the late summer of 1972, all known and mapped passages in Mammoth Cave did not exceed a total length of 55 miles, while more than 85 miles had been surveyed in the adjacent Flint Ridge Cave system.

Then, in early September, explorers from the Cave Research Foundation and the National Park Service crawled and waded their way from the Flint Ridge Cave under Houchins Valley and emerged in Mammoth Cave near Echo River, demonstrating a direct link between the two huge systems. The upper reaches of Echo River extend under the edge of Joppa Ridge, but no direct connection penetrable by man has yet been found between Mammoth and the large caves of Joppa Ridge. Exploration is continuing, and it does not seem too unre-

Hibernating Indiana bats, left, cluster on the ceiling of a secluded part of Mammoth Cave. The pipistrelle bat, below, is a solitary species commonly found in frequently visited areas of the cave.

ARLAN R. WIKER

HOWARD N. SLOANE

alistic to predict that the system may some day reach an aggregate length of 250 to 300 miles.

As explorers probed the vastness of the cave system, the biological exploration of Mammoth Cave kept pace. Historically, it was the larger aquatic troglobites that attracted attention. Echo River, discovered some time after 1837, is inhabited by the cavefishes *Amblyopsis spelaea* and *Typhlichthys subterraneus*, the white crayfish *Orconectes pellucidus*, and the blind shrimp *Palaemonias ganteri*.

The upper part of the river, in what is called the "Roaring River Passage," is an excellent spot to observe aquatic troglobites. In one section of the passage, which we have named the "Shrimp Pools," blind shrimp use their spindly, basketlike mouthparts to strain the bottom silt for microorganisms. Cavefishes also cruise the pools, feeding on the unwary blind isopod *Asellus stygius*, the amphipods *Stygobromus exilis* and *S. vitreus*, and possibly on stray shrimp. Cave crayfish, attracted by the slightest ripple in the water, wander about over the bottoms of the pools, feeding on whatever living prey or dead food they can find.

The most diverse terrestrial assemblage of animals occurs in moist, stalactitic areas. There, dense colonies of the cave cricket *Hadenoecus subterraneus* crowd upside down on the ceilings, blanketing floors and rock shelves beneath with a thin, crumbly layer of black guano. Detritus feeders—millipedes, bristletails, snails, scavenging beetles, and springtails—utilize the cricket guano and are in turn eaten by spiders, mites, pseudoscorpions, harvestmen, and predatory beetles.

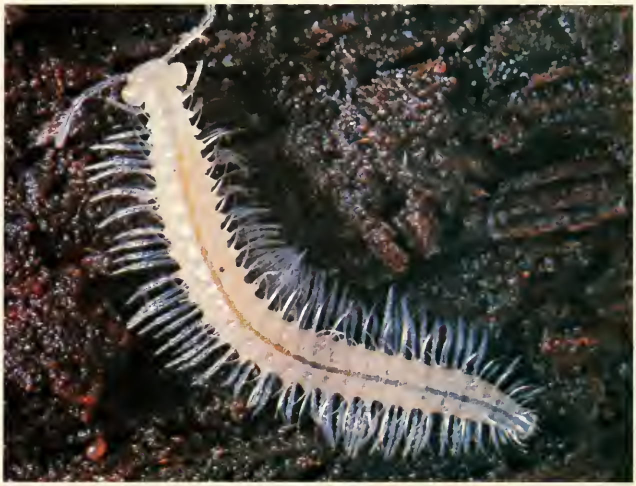
Ancestors of most terrestrial troglobites—living in deep soil and humus—were probably preadapted to a cavelike environment. A richly diverse, moist forest cover seems to favor development of a soil fauna with many species preadapted for cave life; the sparser the forest and the fewer species of trees it contains, the less varied should be the troglobite fauna of nearby caves. This helps to explain the paucity of fauna in Australian caves and my colleague's astonishment at the diversity of Mammoth Cave animal life. The gradual drying of the Australian interior during the Pleistocene probably led to extinction of much of the forest floor fauna, rather than to its survival in caves.

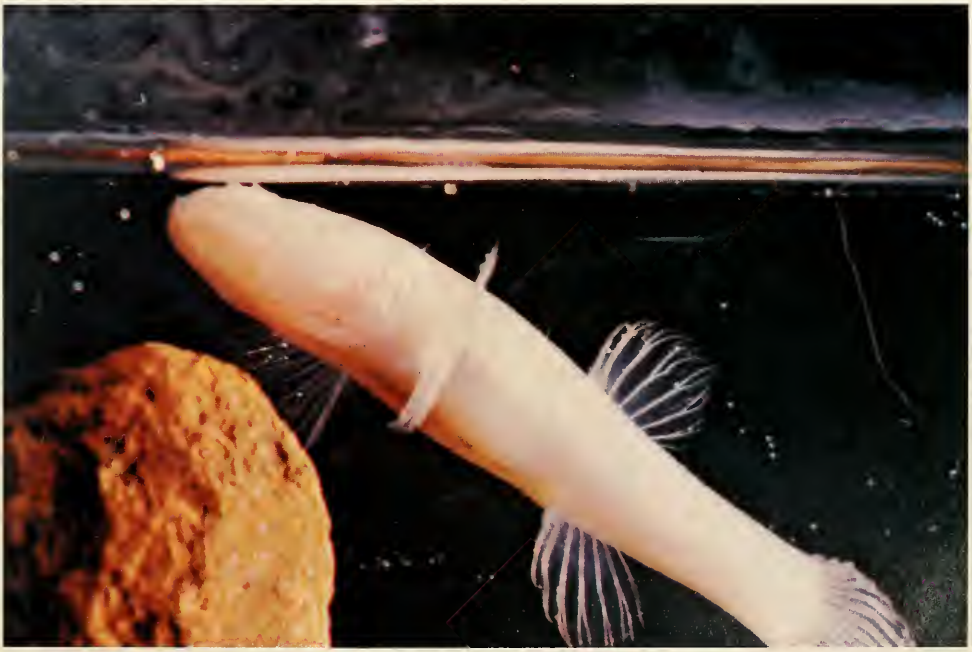
Although forest diversity may provide a partial explanation of the contrast between Australian and Kentucky cave faunas, why should two cave systems in moist, forested regions differ greatly in community complexity? Maximum forest diversity occurs in the tropics, and if this were the sole factor controlling troglobite speciation, we should expect large numbers of troglobites in tropical caves. But this is simply not the case. While tropical caves are occasionally inhabited by aquatic troglobites, terrestrial species are virtually absent.

The richest known troglobite faunas occur instead in regions

The cave crayfish, left, one of Mammoth Cave's largest troglobites, fits into the cave's food web as both a scavenger and a predator. Below, the eyeless millipede is a detritus feeder living on cave cricket guano. The northern cavefish, bottom, is one of two cavefish species found in Mammoth Cave.

THOMAS C. BARR, JR.





HOWARD N. SLOANE

ARLAN R. WIKER

Cave salamanders live in moist regions near cave entrances and frequently feed outside. Their larvae, however, occupy recesses far from cave entrances.

where Pleistocene climates fluctuated between cool and moist periods during glacial maximums and warm and dry periods during the interglacials. Species ancestral to the troglobites occupied cool, moist forests. They could have become widespread in surface habitats during periods of glaciation, gradually being restricted to forested ravines, sinkholes, and caves as the ice sheets retreated and temperatures rose. For a period of time they could have colonized caves and existed as troglophiles, but with increasing temperatures and decreasing precipitation they would have become extinct in the forest floor, surviving only as cave isolates.

If the ancestors of troglobitic beetles and other arthropods passed through a "precave" stage in the forest floor, might there not be a few such ancestral types still surviving in some cool, moist forest, deep in forest floor leaf litter? It was just this question that took me to the Monongahela National Forest in West Virginia. My feet sank lightly into the thick mat of spruce needles that carpeted the forest floor as far as I could see, except for a sprinkling of mossy boulders. After prying up the root-bound boulders for an hour to look deep into the litter mat, I was ready to admit that I was wasting my time looking for Pleistocene beetles in the twentieth century. Turning over one last boulder, however, I saw a small, red beetle. Waving its antennae uncertainly to and fro, it crawled rapidly across the wet black humus. I was momentarily so absorbed with the thought that I had been transported back to the Pleistocene that I almost missed catching it. It was a very close relative of a troglobitic species that inhabits the Greenbrier Valley caves far below, living proof that ancestors of cave beetles could have been already preadapted to life in cool, moist, dark microhabitats in forest floor litter.

Troglophiles are not genetically isolated merely because they have entered a cave. The same cave may be invaded again and again by individuals of the same species, and any tendency to diverge genetically from the parent species will be swamped by interbreeding between the established population and the new immigrants.

Periodic opening and closing of caves through natural geologic processes is not a plausible hypothesis to explain the isolation that must have occurred for ancestral troglophiles to evolve into troglobites. The smaller cavernicoles, in particular, can readily gain access through innumerable sinkholes and small crevices made by seeping water. If a cave were so tightly closed that even these openings were excluded, the food supply from the surface would also be cut off. Only a moderately large aquatic animal could conceivably be isolated fortuitously in a cave, perhaps being swept over a high underground waterfall in numbers large enough to constitute a founder population, and it is only the aquatic animals that seem to become the infrequent tropical troglobites. The concentration of terrestrial troglobites in regions subjected to glacial climates is strong evidence that alternating Pleistocene climatic regimes provided the isolation that permitted troglophile populations to diverge from their surface ancestors.

Once isolated and unimpeded by swamping, the troglophile colonies could proceed to change genetically and become more closely adapted to their cave environment. Inbreeding in small populations leads to reduction in variability, and natural selection becomes more severe, creating a sort of genetic bottleneck through which incipient species must pass. Most isolated, inbreeding populations of this sort, unable to successfully pass through the bottleneck, become extinct; the few that are successful emerge with a modified set of genetic instructions closely tailored to meet the requirements of their immediate environment.

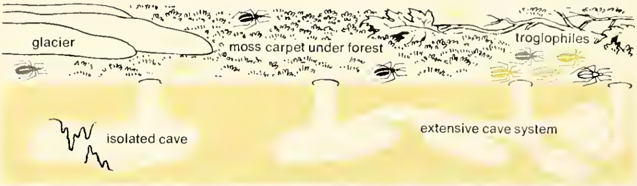
We would expect that the probability of successful cave colonization and subsequent speciation into a troglobite is rather low, but given a large number of caves and a lot of "trial" populations of troglophiles, we could also expect a "success" now and then.

Some pieces of the cave diversity puzzle finally began to fall into place when I began to compare regional faunas and geographical speciation between the caves of the Appalachian valley in Virginia and east Tennessee with those of the Mississippian plateaus in central Tennessee and Kentucky. Although both areas are underlain by thick strata of cavernous limestone, in much of Virginia, Tennessee, and other eastern states, the limestone had been severely uplifted and buckled with the formation of the Appalachian Mountains. Farther to the west, however, the limestone had been relatively undisturbed. Due to the many faults in the Appalachian valley, the limestone areas of that region had become separated from each other as the rock strata had broken and tumbled over. The softer limestones eroded away and became the floors of long valleys sharply separated by ridges of more resistant sandstone and shales where there were no caves. The undisturbed limestone to the west, however, developed extensive cave systems connected to each other through continuous chains of passages and crevices.

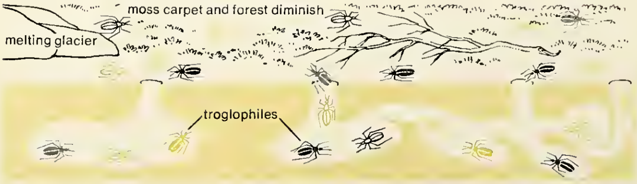
Many elements of the cave fauna were—and still are—incompletely studied, so a total faunal analysis is not possible. I chose to look closely at trechine beetles, small, reddish, eyeless predators widely distributed in caves of eastern United States. A specimen from the back of White Cave had, in fact, been responsible for starting me in the taxonomy of carabid beetles, and when I began this study I had accumulated ample information on more than 150 species of American cave trechines.

Study of cave beetle distribution soon showed that the Appalachian valley had about three times as many species of cave beetles per

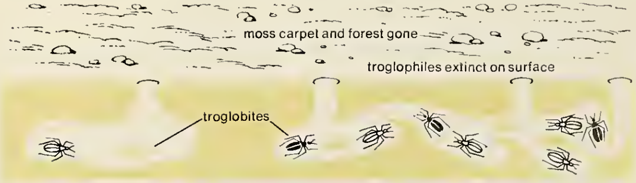
AMNH AFTER BARR



During the early glacial periods when the climate was moist and cool, ancestral beetles lived on the damp forest floor.

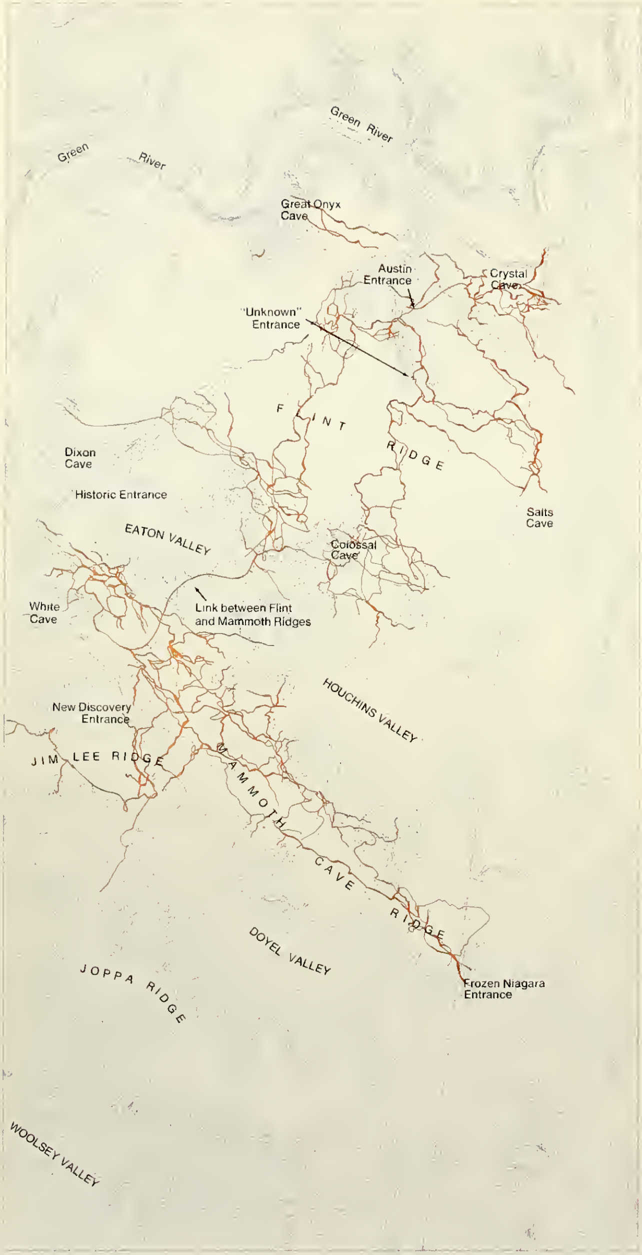


As the glaciers receded, some beetle species on the surface became extinct, but others survived in the moist caves and the diminishing forest. These surface and cave beetles interacted; therefore no separate species developed.



Isolated in caves by an arid postglacial climate, different species of blind, depigmented beetles developed from the ancestral beetles. Due to dispersal passages and a greater variety of niches, more species evolved in larger caves than in smaller ones.

AMNH AFTER QUINLAN


Green River
Green
River
Great Onyx Cave
Austin Entrance
Crystal Cave
"Unknown" Entrance
FLINT RIDGE
Dixon Cave
Historic Entrance
Salts Cave
EATON VALLEY
Colossal Cave
White Cave
Link between Flint and Mammoth Ridges
HOUCHINS VALLEY
New Discovery Entrance
JIM LEE RIDGE
MAMMOTH CAVE RIDGE
DOYEL VALLEY
JOPPA RIDGE
Frozen Niagara Entrance
WOOLSEY VALLEY

The Mammoth Cave system may extend across three ridges. Late in 1972 a passage was found linking Mammoth Cave to the Flint Ridge Cave system. A Joppa Ridge connection has not yet been discovered.

square mile of limestone terrain as did the broad and cavernous plains of Mississippian limestone to the west. This is an excellent example of geographic speciation.

A cave in the Appalachian valley is connected only to other caves in the same narrow strip of limestone. Exposures of limestone in this area are, with a few exceptions, highly discontinuous, and a specific beetle species is usually found in only one or two caves, the expansion of its range being prohibited by numerous sandstone and shale barriers. Only four of several hundred caves have two species, and none have three or more.

Individual Mississippian plateau caves, however, often have two or more species inhabiting them. A kind of world record for cave beetle sympatry seems to have been set in White Cave, where no less than six species of eyeless trechines coexist. The caves in the continuous, unbroken belts of Mississippian limestone are presumably connected to each other by innumerable cracks and crevices; thus, beetle species have extensive ranges, occurring in many caves over wide areas.

In areas of continuous cavernous limestone similar to the karst of central Kentucky, a troglobite can disperse by moving from cave to cave through underground openings. From this point of view, a cave becomes a sort of window through which man can sample a troglobitic species at different points in its geographic range. Theoretically, the species can appear in every cave community in the same continuous limestone mass, so any given community can be composed of species whose ancestors successfully colonized different caves at different times in the past.

Such communities may also include a few widely distributed subterranean spiders, springtails, and small crustaceans, which in addition to having all the attributes of troglobites, are equally well at home below ground in nonlimestone terrains. And to the troglobites must be added a variety of troglophiles and trogloxenes of recent vintage, all three groups of animals interacting with each other and with the microbial flora and fauna to sustain the dynamics of the cave ecosystem.

These observations on beetle speciation and distribution are best explained by a simple model. Let us imagine two areas underlain by cavernous limestone, one quite large, with 100 caves; the other small and with only one cave. Suppose each cave is colonized by a troglophile beetle that, because of a warming climatic trend, subsequently became extinct at the surface. As we have seen, the likelihood of making the transition from troglophile to troglobite is rather low. For each cave population there will be a fixed but low probability that the population will successfully evolve into a troglobite—arbitrarily we can assume one chance out of a hundred. In the small area there is only a 1 percent chance that a new troglobite will evolve, but in the large area the probability is 100 times greater; that is, it is almost certain that at least one troglobite will evolve there. Since the large area is continuous and cavernous and not broken up by shale and sandstone barriers, interconnecting crevices exist between the caves through which the troglobites can crawl. It is only a matter of time before all of the hundred caves are occupied by the troglobitic beetle that originally evolved in only one cave.

If, despite the odds, a troglobite did evolve in the single cave of the small area, its geographic range would be limited to that one cave because it could not crawl out of the cave and move overland to another cave.

If we now take our hypothetical model and suppose that the caves are colonized not only by beetles but also by spiders, millipedes, springtails, bristletails, isopods, amphipods, and so forth, we would have a closer approximation of what actually took place in caves of the eastern United States. Further model refinements are possible, particularly in weighting probabilities of speciation differently for different sorts of ancestors, but in the present simplified form it is adequate to help us understand how cave communities develop.

In applying our model to the Mammoth Cave community, we can analyze the geographic ranges of its forty or more species of troglobites. These include flatworms, snails, spiders, harvestmen, pseudoscorpions, mites, copepods, isopods, amphipods, crayfish, shrimps, springtails, bristletails, beetles, and blind cavefishes. A look at troglobite

Continued on page 72

Mushrooms are known to sprout from the silt floor of only one area of Mammoth Cave. They were first seen in this area in 1870.

THOMAS C. BARR JR.

The Lost Vikings of

Marauding Norsemen of the early Middle Ages were also peaceful colonists of new lands

Eric the Red, the Norse chieftain who discovered and colonized Greenland in about A.D. 985, and his son Leif, also known as Leif the Lucky, who discovered America about the year 1000, are Scandinavian heroes. Legends of their courage and adventurousness form a part of the history in which we take justifiable pride and serve as a welcome counterbalance to the unsavory reputation the Vikings acquired in western Europe in the early Middle Ages.

During the ninth and tenth centuries, the years of the Viking era, the then pagan Norsemen repeatedly raided the Christian countries of England, France, Germany, and Ireland, where they pillaged, burned, and killed, leaving behind a wake of hatred and fear. Wild warriors whose passion for battle transported them into frenzies during which they were said to bite their shields, foam at the mouth, and howl like wolves or growl like bears, the Vikings were called "berserkers" by their peers. That appellation has survived in the English language in the word *berserk*.

Before the end of the Viking era, these adventurers had sailed from the fastnesses of their northern fjords through the Strait of Gibraltar into the Mediterranean and had penetrated south to the Black Sea via the Russian waterways. Despite their intelligence and superb navigational skills, the Vikings were deemed so barbaric by their contemporaries that a special prayer for protection against them was offered in European churches: "God deliver us from the fury of the Northmen."

There was, however, a more constructive side to the Vikings. When they voyaged to places not yet settled, such as Iceland, Greenland, and Vinland, as they called North America, they developed their own culture and demonstrated a capacity for government and peaceful community organization.

Our main sources of information about the 500-year Viking colonization of Greenland and the Scandinavian voyages to Vinland are the sagas of Old Norse literature. But these fragmentary, ancient accounts of the lives of kings, the feuds of chieftains, and the exploits of venturesome men crossing the sea in open boats are often dismissed as nothing more than fables. Now, with the publication during the last decade of Yale University's pre-Columbian Vinland map and the archeological discoveries in Greenland, some of the material in the sagas has been corroborated. The shadowy centuries of Viking settlement in Greenland have become more concrete and our knowledge of what the life of Norse common folk was like during the Middle Ages has been augmented. The sagas can be read without reservation as lively and exciting period descriptions. They give in broad outline an authentic picture of the times and usually correct information about personages and events.

Two sagas in particular tell of Norse adventures in Greenland: *The Saga of the Greenlanders* and *Eric the Red's Saga.* All the sagas, of which there are many, were originally communicated orally. It is not certain when these spoken tales were first written down, but the classic sagas are thought to have been transcribed in Iceland in the thirteenth century and later incorporated into more comprehensive manuscripts. *The Saga of the Greenlanders* is thus found in the *Flatey Book,* an extensive late-fourteenth-century codex. *Eric the Red's Saga* is contained in two documents: the *Hauk's Book* and the *Skalholt Book,* both of which appear to be based on a common source dating back to the end of the thirteenth century.

Greenland is the world's largest island. It lies mainly within the Arctic Circle, closer to the North American continent than to Scandinavia. Most of its 840,000 square miles is steeply mountainous plateau, covered by an ice cap 1,000 or more feet thick. Numerous fjords indent its coasts.

This sizable land mass was first sighted by a European in about the year 900, when a Viking sailor voyaging from Norway to Iceland was driven westward off his course by storms. All he saw of the island on the distant horizon was its inhospitable, ice-packed east coast ringed with rock outcroppings. He did not go ashore, but he did carry back to Iceland word of a new land to the west, and the story persisted for generations.

Iceland had been settled in the mid-ninth century by Norsemen fleeing the domination and oppressive taxation of King Harold I of Norway. Among the colonists living there toward the end of the tenth century was Eric the Red, named for the color of his hair and beard. In 982, Eric was banished from Iceland for three years as punishment for killing several fellow Norsemen in a feud. Recalling the report of a land to the west, he set out to find and explore it during his banishment. For three years Eric systematically reconnoitered Greenland's ice-free southwestern coast, milder

Hvalsey church is the best-preserved ruin in the East settlement. Christianity was introduced to the Viking colonists of Greenland by Eric the Red's son Leif in about the year 1000.

Greenland

by Jørgen Meldgaard

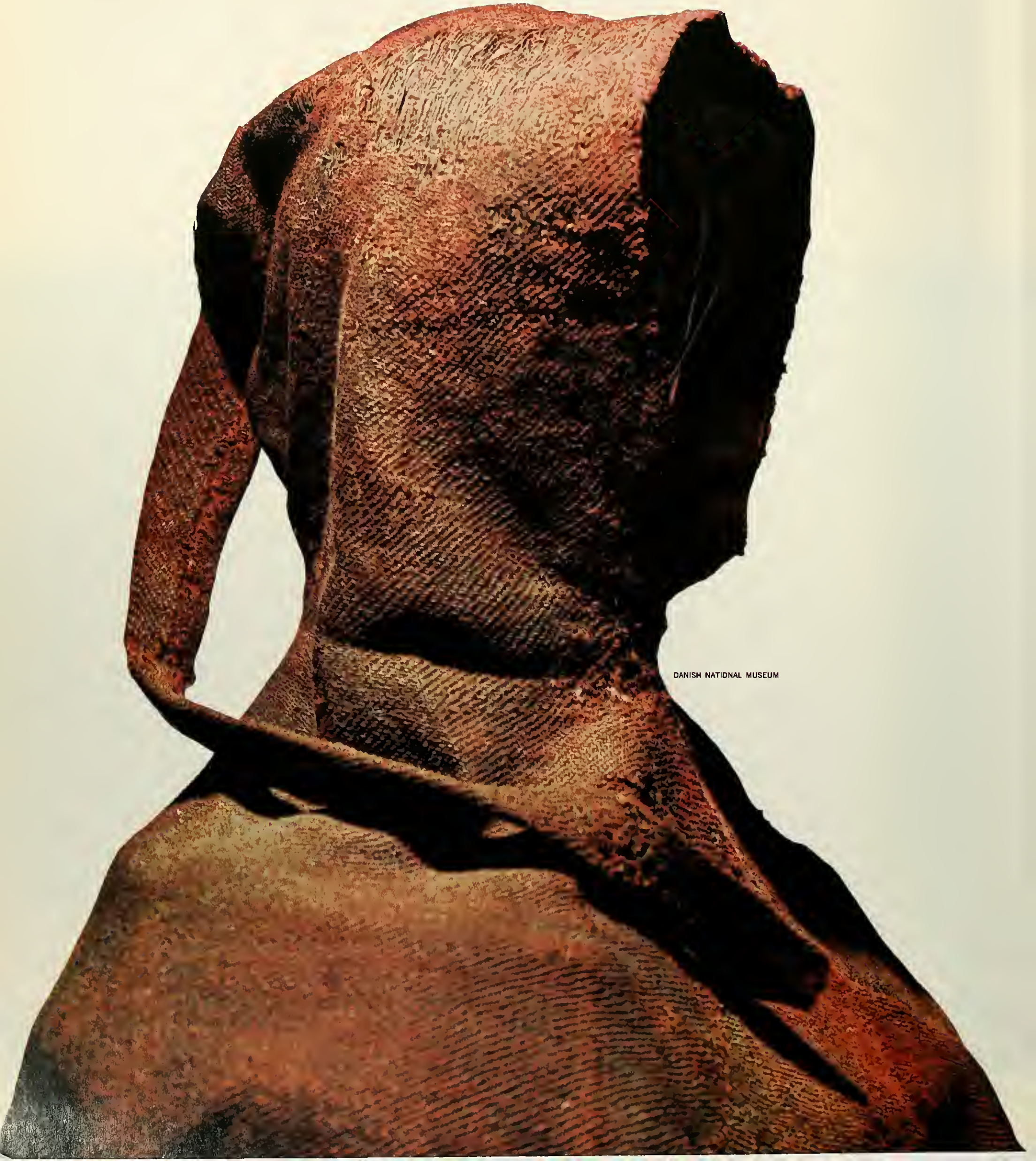
and more fertile than the island's forbidding eastern shore, looking for a suitable place for settlement.

The climate of Greenland in Eric's time, like that of the rest of the earth, was more benevolent than it was later to become. There is no mention in the sagas that he encountered ice drifts, now common in far northern waters. On his return to Iceland, Eric told of a land of fertile pastures, which he called "Greenland" in order to entice farmers to join him there in colonization.

In the summer of 985, thirty-five ships carrying 300 to 400 men, women, and children, together with cows, horses, sheep, and household effects, set sail from Iceland for a new home in Greenland. According to the sagas, only fourteen ships arrived safely, some being wrecked in passage and others being driven back to Iceland by wind and weather. A colony known as the East settlement was founded on the Greenland coast near the present Julianehaab, and shortly after, a second colony known as the West settlement was formed about 250 miles northwest near today's Godthaab. The distance between the two settlements was calculated as being a six-day row in a six-oared boat. Eric the Red built his own farmstead at Brattahlid in the center of the East settlement and near the present town of Narssaq.

S. E. ALBRETHSEN

This well-preserved liripipe hood was dug up in a Greenland churchyard. Such hoods, customarily worn in fourteenth-century Europe, had never been found before.



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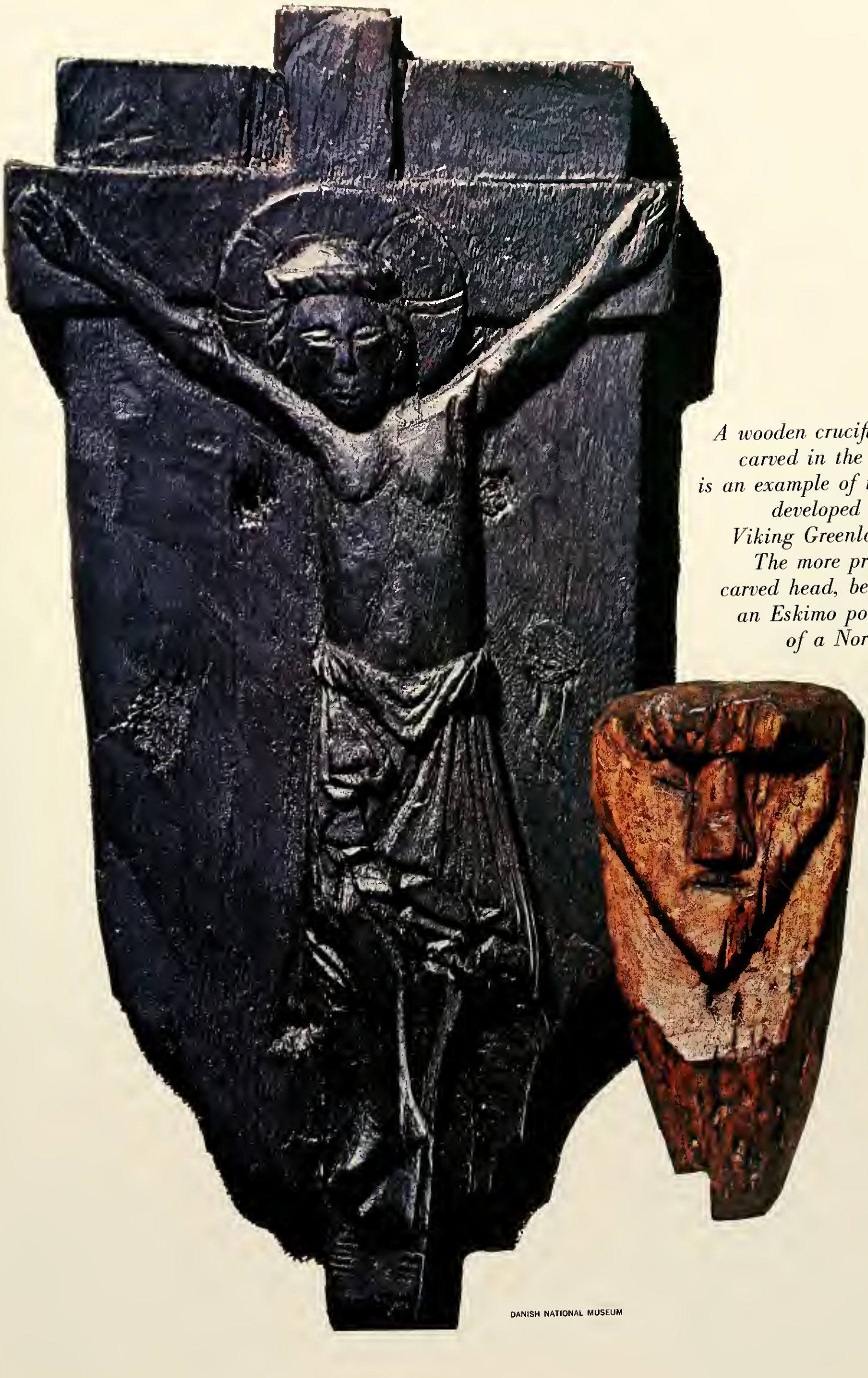

A wooden crucifix left, carved in the 1300s is an example of the art developed by the Viking Greenlanders. The more primitive carved head, below, is an Eskimo portrayal of a Norseman.

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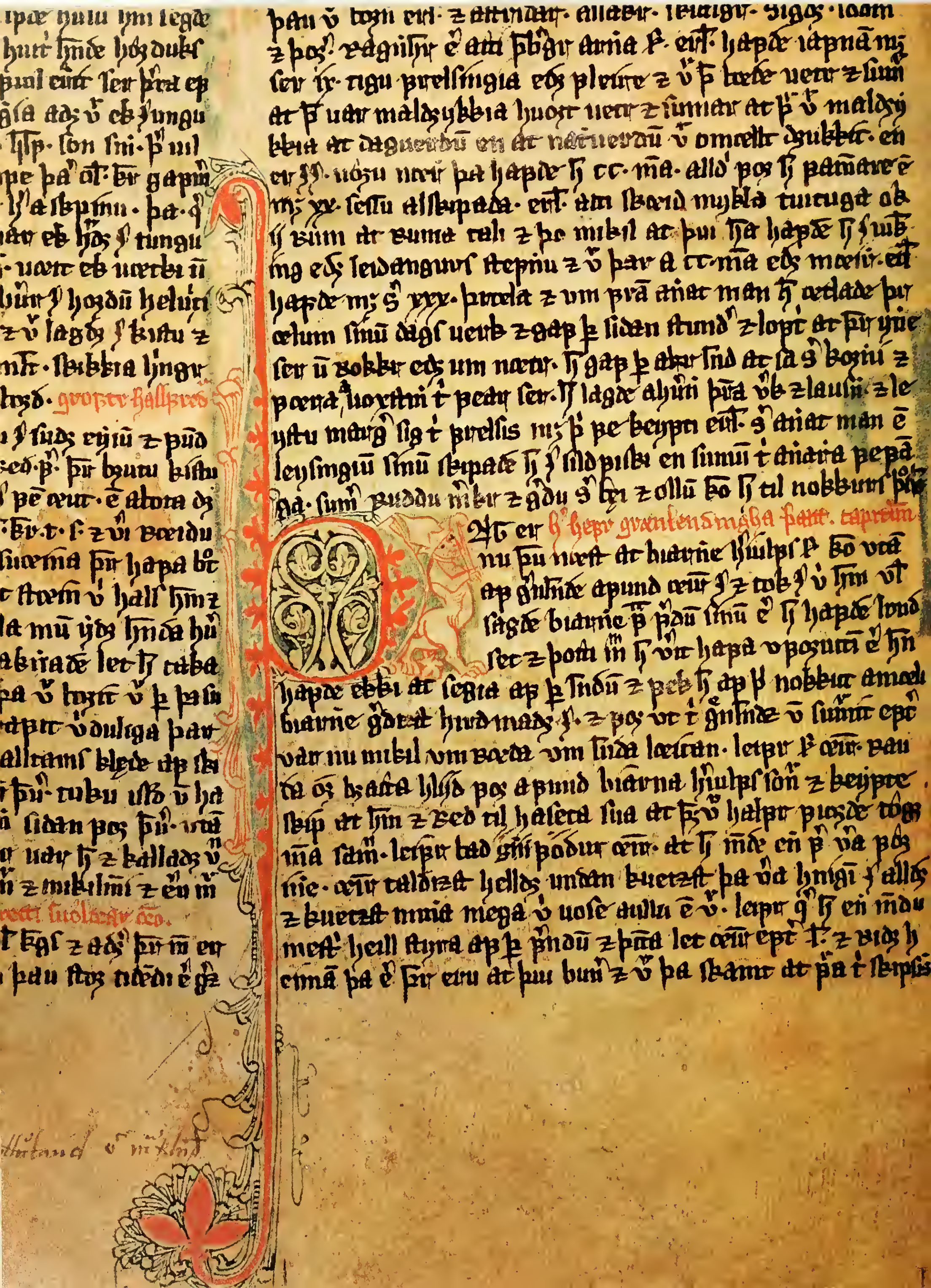

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The Flatey Book, *a fourteenth-century Icelandic manuscript, contains* The Saga of the Greenlanders. *The last fifteen lines of this page introduce the story of Leif the Lucky's voyage to Vinland.*

It was from Brattahlid some time after the year 1000 that the celebrated Vinland expeditions to the northeast coast of the American Continent set forth, voyages of discovery associated with the name of Eric's son Leif. On those expeditions, the Vikings first encountered Indians and Eskimo, the Norsemen called them "Skraellings." In Greenland, the colonists found traces at their two settlements of the presence of Eskimo on the huge island, but the native inhabitants lived far to the north and there is no record that the two populations met for several centuries.

Despite the hazardous voyage from Iceland and Norway to the Greenland settlements, more and more Viking families made the journey, seeking land and a measure of independence. These enterprising and hardworking colonizers built houses, cultivated farms, bred cattle, wove cloth, hunted, fished, traded with Europeans, and generally prospered. What kind of people were these kinsmen of the Vikings who had earlier been the scourge of Europe? A mid-thirteenth-century Norwegian document known as *The King's Mirror*, written by an anonymous scholar in the form of a conversation between a father and son, has this to say about the Greenland settlers:

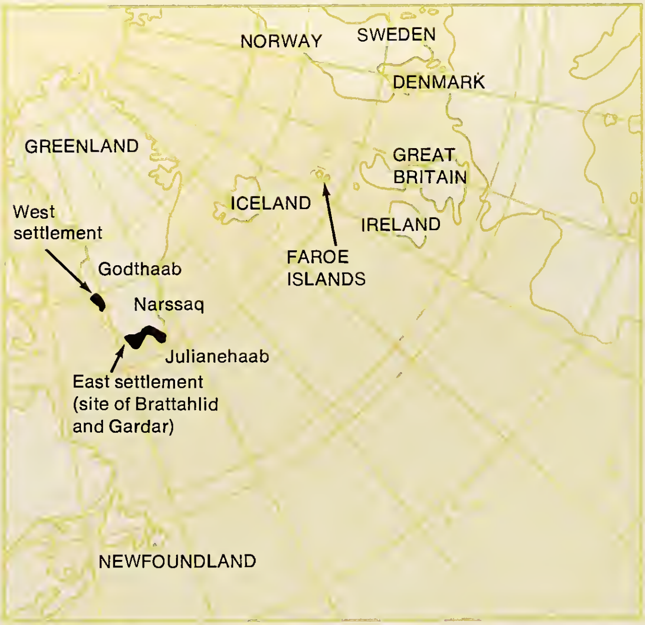
"As you are anxious to know what one looks for in that land, or why one goes there at such great peril, it is that one is moved to do so by the threefold character of human nature. One part thereof is the spirit of rivalry and the craving for fame; for the nature of many men drives them to go where great danger can be expected, in order to become famous by doing so. The second is the thirst for knowledge; for in man's nature lies that inclination to explore and see things of which he has before been told, in order to know whether it is as he has been told or not. The third thing is the hope of wealth; for men look for that wherever they learn that gain can be expected, regardless that great dangers threaten on the other side."

Like their mainland relatives, the early Greenland Vikings were pagans who worshiped such Norse gods as Odin, Freya, and Thor. But in 1000, the same year that he discovered America, Leif Ericson introduced Christianity to the Greenland settlements.

According to the Icelandic sagas, fourteen years after Eric the Red settled at Brattahlid, he sent his son Leif to Norway to spend time at the court of King Olaf Tryggvason, as was customary for chieftains' sons. Leif's visit came at a time when the king, having been converted himself, "harried the country to Christianity." Olaf destroyed the pagan temples, forbade the practice of sacrifices, forced his subjects to be baptized, and if they resisted, put them to death.

The sagas report: "The king found Leif no problem. He was baptized with all his shipmates, and spent the winter with the king. . . . That same summer [the year 1000] King Olaf sent Leif Ericson to Greenland to preach Christianity there. The king provided him with a priest and various other holy men to baptize folk there and instruct them in the true faith. Leif set sail for Greenland that summer, and while at sea picked up a ship's crew of men who lay helpless there on a wreck. On this same journey he found Vinland the Good [America]. He reached Greenland at the end of the summer and went to lodge at Brattahlid with Eric his father. From this time forward men called him Leif the Lucky, but his father contended that one thing cancelled out the other, in that Leif had rescued a ship's company and saved the men's lives, but had also introduced a man of mischief [as Eric styled the priest] into Greenland."

The sagas continue: "Leif soon preached Christianity throughout the country," but "Eric took coldly



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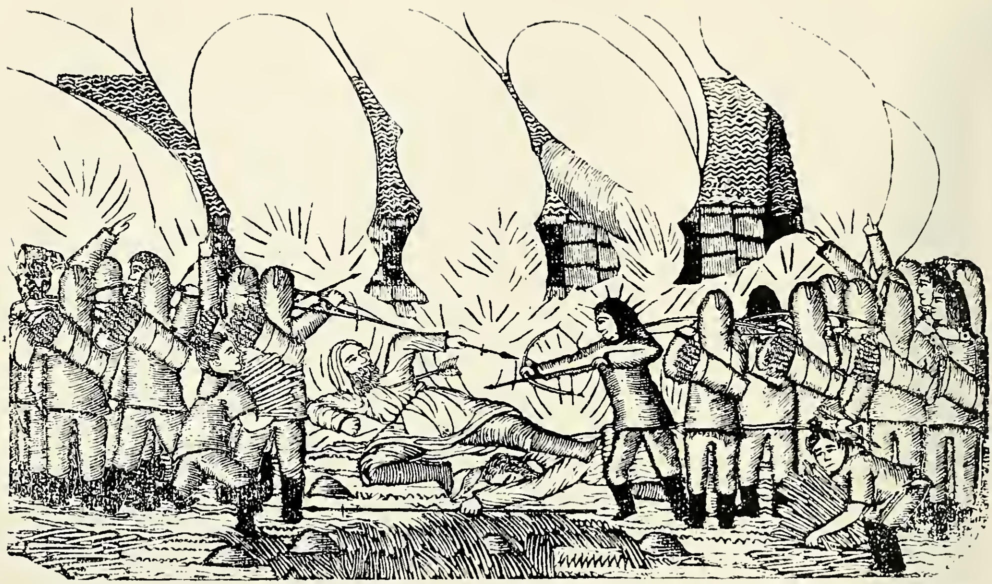


DANISH NATIONAL MUSEUM

A nineteenth-century woodcut shows Eskimo, at right, attacking Vikings. A cold period in the Middle Ages caused the Eskimo tribes to migrate southward.

to the notion of abandoning his faith." Thjodhild, Leif's mother, embraced Christianity at once. She had a church built behind the brow of a small hill, just out of sight of their farm, and there she "offered up her prayers, along with those men who adopted Christianity, who were many." Because her husband refused to be converted, Thjodhild would not live with Eric as man and wife once she had taken the faith, "a circumstance which vexed him very much."

By 1126, when the Viking population on Greenland numbered about 4,000 to 5,000 colonists working some 280 farms, an ecclesiastical see was established at Gardar, a large farm in the East settlement, and the island got its own bishop. Several ecclesiastical buildings, including sixteen parish churches, a cathedral, a monastery, and a nunnery were subsequently built at the settlements.

Greenland had been a republic, but in 1261, the Norwegian crown gained direct control over the island. King Haakon IV imposed taxes on the settlers and a fine for manslaughter, the *wergeld.* There were few oceangoing ships, and in the following century contact between Greenland and Europe steadily diminished. Gradually the colonies declined. By about 1350, the once flourishing West settlement was deserted. The last authenticated historical light on the East settlement comes from ecclesiastical archives. It is a declaration of the solemnization of a marriage that took place on September 16, 1408 at the Hvalsey church. Many of those who attended the wedding left the settlement in 1410 on the last ship from Greenland of which there is any record. Archeological evidence suggests that the settlement was still inhabited by a few struggling Viking families at the time that Columbus crossed the Atlantic, but by the beginning of the sixteenth century, the East settlement too was deserted. From that time until the start of Danish colonization in the 1700s, the only inhabitants of Greenland were the Eskimo.

We do not know why the Viking colonists became extinct. They may have been exterminated by hungry, marauding bands of Eskimo. The writings of a Norwegian priest, who was made the leader of an expedition from the East settlement to rescue the West settlement in about 1350, say: "when [the expedition] got there, they found no people, neither Christians nor pagans, only wild cattle and sheep." And the *Icelandic Annals*, which occasionally report Greenlandic events, has this 1379 entry: "Skraellings attacked the Greenlanders, killing eighteen of them and carrying two boys off into captivity."

We know that the climate of Greenland deteriorated in the fourteenth century when the whole earth got colder. The general cooling favored the southward migration of the Eskimo tribes. And the buildup of the Greenland ice cap may have partly closed the fjords to navigation and made it difficult, if not impossible, for the Vikings to breed cattle, their principal means of livelihood. A wide band of drift ice now enclosed the coasts of

South Greenland. After about 1350 the kings and the merchants back home in the Scandinavian countries found the route to Greenland so perilous and unprofitable that communication gradually ceased.

Some aspects of Norse life in Greenland can be clarified by archeological finds, which supplement the written records. The work of historical reconstruction can be said to have begun in 1721 with the arrival in Greenland of the Norwegian missionary Hans Egede. Dispatched there by royal command to search for traces of the vanished Scandinavian settlements, he traveled to their sites and sent back to Copenhagen descriptions of what he saw. Over the next 150 years similar reports were sent back by Danish officials. These descriptions augmented our knowledge of the topography of the settlements' farms and churches. But the most important source material did not come to light until Capt. Daniel Brunn, a Danish geographer, started excavations in the East settlement in 1894 and the West settlement in 1903. His diggings established the size of the two settlements and the sites of specific farms and churches and showed for the first time what the farmsteads, sheepfolds, outbuildings, and houses had looked like. Several church ruins were identified and renamed with the help of existing literary sources. Such historical sites as Eric the Red's farm at Brattahlid and the ecclesiastical seat at Gardar were located, along with other ruins deep within the fjords of the Julianehaab district.

Brunn's work wasn't followed up until 1921, when archeologists began to concentrate on excavating specific farms, churches, and graveyards. That year, while digging slowly through the frozen ground of a churchyard at the extreme south end of the East settlement, the Danish archeologist Poul Nørlund, made a most important discovery: opening some graves, he unearthed a collection of astonishingly well-preserved ordinary clothing. Made of the Greenland homespun celebrated in the Middle Ages, the apparel is the only major collection in existence of the everyday medieval dress typical of northern Europe.

The fine garments of medieval nobility and clergymen, well preserved by subsequent generations, are familiar to us. But here, at the end of the earth, the "Ultima Thule" of ancient times, was a glimpse of the less familiar raiment of ordinary men and women: dresses, cloaks, and liripipe hoods. In their cut and styling, these clothes followed the fashions of Eu-

Continued on page 74

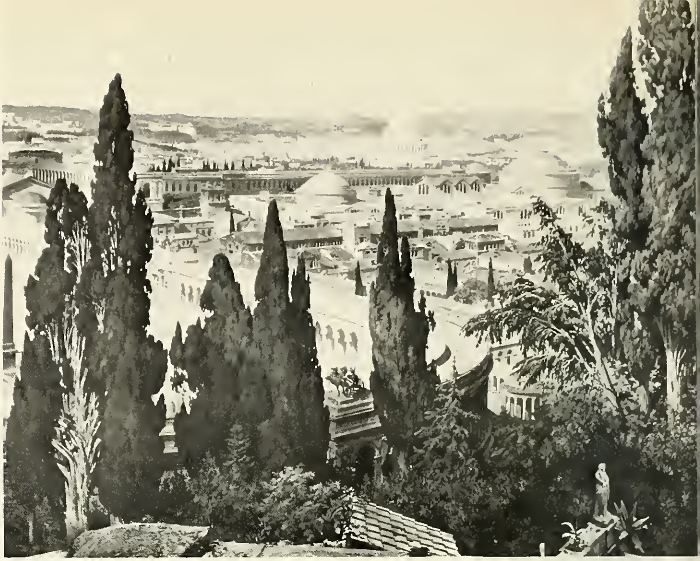
Skulls of early Vikings were excavated in the graveyard of Greenland's first church. In life, some of these Norsemen crossed the Atlantic to America.

DANISH NATIONAL MUSEUM

The Squalor That Was Rome

Clattering wagons, reeking stockyards, and a corpse-filled Tiber were all part of life in the first great Western city

by Theodore Crane



A section of a cycloramic representation of Rome in A.D. *312.*

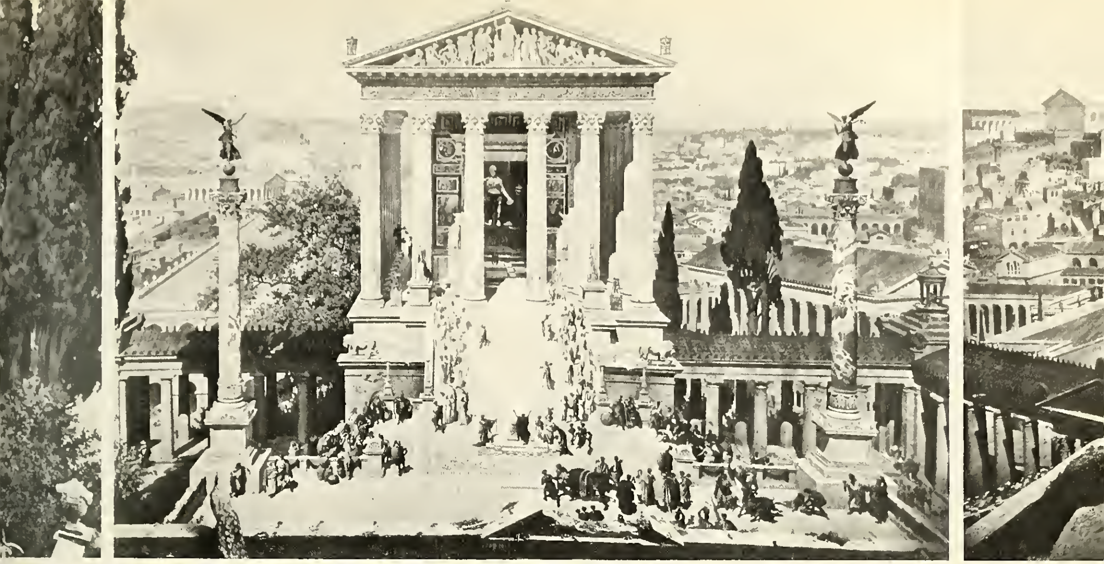
As civilization becomes increasingly urbanized, questions about the quality of human life in a city setting become more pressing. Yet these problems are as old as the first great Western city; two thousand years ago, Roman citizens faced the same questions. Like most cities, ancient Rome became more polluted as it became more populous. Its population—concentrated in the area of the Seven Hills—overflowed into the Trastevere, a suburb on the other side of the Tiber River, but this did little to relieve the general congestion. This section did not even receive aqueduct service until the early second century A.D. It is difficult to estimate Rome's population for the Republican period (509 B.C. to 27 B.C.), but during the reign of the first emperor, Augustus (27 B.C. to A.D. 14), there were about 750,000 inhabitants in the city, and perhaps three and one-quarter million people in all of the Italian peninsula.

These are conservative figures since the official census did not usually take into account women, slaves, or men under the age of eighteen. Roman censors never evolved a system of determining the death or birth rates of their citizens; there were no laws requiring the registration of births or deaths. Most corpses were ritually interred, but many were simply thrown into shallow trenches in "graveyards" that doubled as neighborhood dumps. Burial was a family matter left to the discretion of the surviving relatives, and those who could not afford even minimal expenses are commemorated in an old law forbidding the random disposal of corpses in roadside ditches and public parks. Eventually, religious sanctions forbade burials inside the city limits. But as late as A.D. 69 the historian Suetonius noted, as one of the omens portending the accession of the emperor Vespasian, that a stray dog dropped a human hand at his feet under his breakfast table.

Ancient Rome's method of disposing of its wastes would be known today by the euphemism "stream assimilation," that is, all principal sewers emptied into the nearest river. The city's largest main sewer, the Cloaca Maxima, carried off mostly surface water accumulated after rainstorms. It was a stone tunnel 14 feet in diameter, and the Romans took pride in the fact that it was possible to row a boat along the sewer's quarter-mile length beneath their city streets. Many smaller drains were channeled into the Cloaca Maxima and the latrines of some private residences were connected to these smaller sewer lines. Most families, however, could not afford their own private hookups, for which a fee and permit were required. Furthermore, as the city grew, most public lines were obscured or bisected by new building construction.

To add to the confusion, Rome had no city planning authority, and the streets had never been laid out on the grid system. Thus, the public drains rarely ran parallel to the streets, and they were difficult to find. Except for the expensive ground-floor apartments, the rooms of the large seven- and ten-story apartment houses had no individual plumbing at all; upstairs residents were obliged to empty their wastes into a basement cistern. Many followed the simpler expedient of dumping their chamber pots out a window into the street below.

Apparently, both public and private buildings were carelessly constructed at every stage of Rome's development. Referring to other hazards of city life, the satirist Juvenal describes the cracked walls of dilapidated townhouses clumsily propped up with wood beams and mentions the ever present danger of sudden injury or death from a falling roof tile. Except for occasional government regulations, the Romans never developed building codes as we know them today. There is no evidence to indicate that any standards were required of contractors other than regulations controlling the height of walls and the distance between buildings. The restrictions on height applied only to that part of the structure fronting



From *Das Alte Rom*, by J. Bühlmann and Alex von Wagner, Munich, 1890.

on the street. Roman writers of the late first century A.D. complained that public buildings often collapsed of their own accord, so we can assume that the condition of private houses was far worse.

Most townhouses were constructed to accommodate ground-floor retail shop stalls facing the street, a building style that tended to obstruct the city's thoroughfares, and each householder was legally responsible for the upkeep of the section of public street in front of his own home. Many streets were too narrow to permit sidewalks or two-way traffic; most were little more than dirt pathways meandering through the maze of houses and temples. Suetonius notes that when Vespasian was curator of Rome's streets before he became emperor, Caligula had him covered in mud because he had neglected his duties. This prank suggests that most streets were unpaved even in the first century A.D.

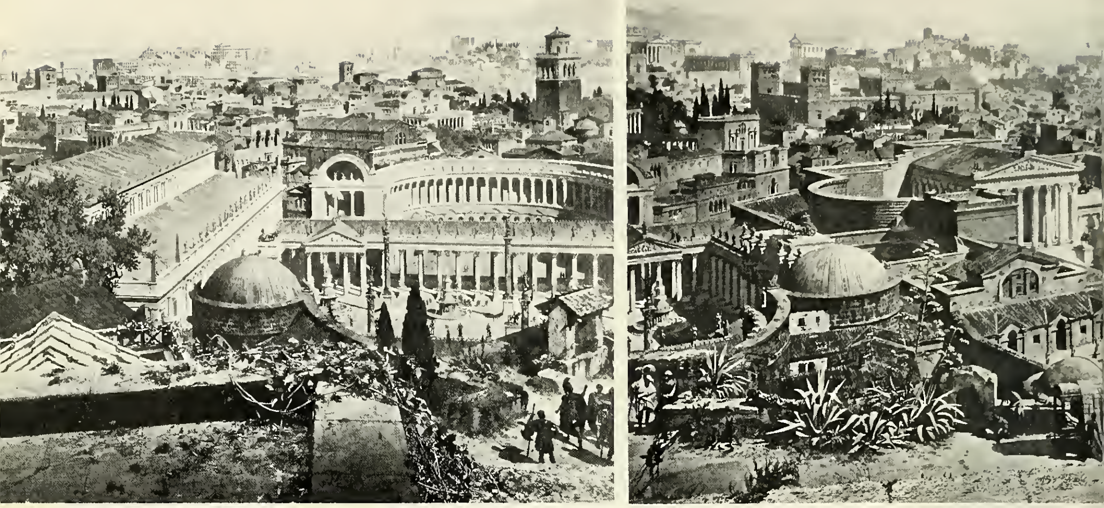
The manipulation of heavy construction vehicles on such streets was difficult, and Juvenal writes of unwary pedestrians crushed to death under overturned wagonloads of marble. Julius Caesar issued a law prohibiting horse-drawn vehicles and all commercial traffic within the city limits from sunrise until five o'clock in the afternoon; the consequent noise pollution at night must have been intolerable for those who lived along the main avenues. Elections, festivals, triumphs, and funerals, as well as pedestrian shoppers, street vendors, and musicians all contributed to the noisy daily life of the ancient world's largest city.

Roman writers were fond of comparing water to air and preferred certain types of water to others in much the same way that they considered various winds harmful or healthy depending upon their origin. The physician Celsus alleged that south winds and wet or hot winds were unhealthy, while warm, dry west winds were best. Frontinus, Rome's curator of aqueducts at the end of the first century A.D., asserted that the inner city's abundant supply of clean water made the urban atmosphere more pure. Since not all of the city's sewers were covered, they were an irritating source of air pollution, and some of the aqueduct water was used to flush them out. Rome's central cattle market and the adjoining open-air fish market contributed their own special flavor to the surrounding neighborhoods. A smelly tannery across the Tiber further contaminated the atmosphere.

Nevertheless, the city air was comparatively clean and during the day there was little general pollution other than the smoke of blacksmiths' forges and smelters' hearths. But at night the air was thick with the haze of cookfires—the poet Martial refers to the cold month of December as "smoky." Since Roman fireplaces were not built with chimney flues, the smoke from open hearth fires and large chandelier-type oil lamps was left to rise to the ceiling and out through a window or roof hole.

Fire was a constant threat in ancient Rome and several conflagrations, comparable to the Great Fire of London and the Chicago Fire, occurred. The upper stories of most buildings were built entirely of wood, and their roof shingles were waterproofed with extremely flammable pitch pine. Many early Roman temples and shrines had originally been built of wood with straw-thatched roofs. Such buildings were quick to catch fire. Since the Roman gods were thought to be averse to any changes in their temple design, these buildings were always rebuilt in their original style, and so burned down repeatedly. The temple of Vesta, which housed Rome's Eternal Fire, was traditionally serviced by six vestal virgins and, coincidentally, was burned six times. Finally, by a special act of the Senate, the temple was fitted with a bronze roof.

Although a fire-fighting force had been organized by Augustus, it was relatively ineffective against large fires because the old "bucket brigade" method, dating from the days



of Romulus and Remus seven centuries earlier, continued to be used. It is unlikely that aqueduct water could have been used as a spray in fire control because of the low pressure and lack of flexible hose.

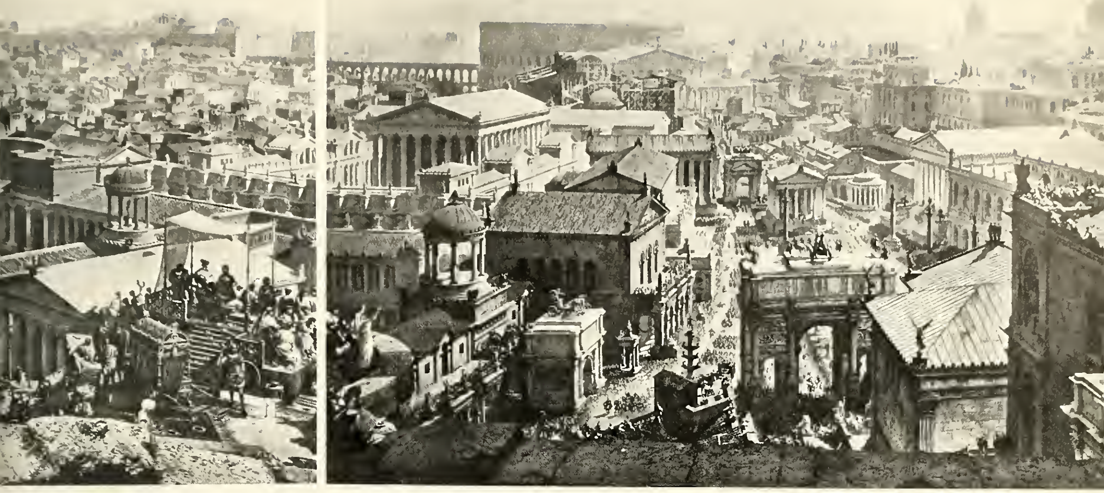
In A.D. 64, under the reign of the emperor Nero, Rome suffered the effects of a fire that burned for seven days. It was known as the Great Fire until one of similar proportions ravaged the city about twenty years later. Taking advantage of this opportunity, Nero quickly appropriated 125 acres of razed public lands for the building of a new palace known as his Golden House. Other areas of the city were gradually rebuilt in more practical ways, but no sweeping urban improvements were carried out as Roman writers were still complaining a few years later of Rome's narrow, twisted streets.

According to Frontinus, Rome had three principal sources of drinking water: the Tiber River, springs and wells, and the aqueduct water, which he supervised. Winter rains caused annual flooding of the Roman Forum, which in ancient times was only 11½ feet above the mean level of the Tiber. By the eighteenth century the Forum had become little more than an alluvial plain—in some areas modern archeologists have had to remove as much as 60 feet of silted earth. Other low-lying sections of the city were often flooded to a depth that required the use of boats. High waters contaminated wells and weakened the foundations of buildings, which subsequently fell into ruin. These floods were traditionally considered manifestations of divine anger; thus for 700 years relief was sought, not in civil engineering techniques, but in sacrifice and prayer.

Pollution of the river had not always been confined to the bloody carcasses of sacrificed bulls. According to a dim tradition, Rome's superfluous population had once been disposed of by drowning all 60-year-olds in the Tiber. The river was also continually contaminated by the corpses of executed criminals, and political factionalism occasionally led to the slaughter of persons whose bodies were first thrown into the main sewer and then washed into the river. The Cloaca Maxima was also the temporary resting place for the corpses of seven saints, notably that of Saint Sebastian.

For 300 years Rome was serviced by only two aqueducts and relied heavily for its drinking water on wells and springs in addition to the Tiber. The Romans performed sacrifices to their favorite springs, polluting them from time to time with the blood of a victim, usually a young goat or calf. Once aqueduct water became available in the central city areas by the first century A.D., most Romans drew their water from neighborhood fountains and storage tanks. The ancient city boasted more than 1,200 fountains and 300 tanks fed by a network of aqueduct pipelines. Washing clothes or watering livestock in these tanks was against the law, as was the pollution of public drinking fountains.

Carcasses of animals exhibited and killed for entertainment in the city were another possible source of river contamination. While he was emperor, Augustus showed some 3,500 animals; succeeding monarchs followed his example on an even larger scale. Special occasions called for extravagant shows. During the celebrations at the opening of the Colosseum under the emperor Titus, 9,000 beasts were killed. To procure live wild animals for use in Roman festivals and shows, huge corporations based in Rome maintained overseas offices in Egypt, North Africa, and as far away as India. Lions, tigers, panthers, and spotted leopards were the most sought after, but there was always a popular demand for unusually large snakes, elephants, and giraffes. Stockyards and cages existed in one section of Rome to house and feed the various forms of wildlife. Occasionally, some of the big cats escaped, mauling and killing passersby and causing havoc at



night in the unlighted streets. Those animals that survived the shows and contests in Rome usually found homes in municipal zoos. But the majority were slaughtered in the arena and their unpalatable carcasses were probably disposed of in the river.

Rome was eventually serviced by eleven aqueducts. Their combined output has been estimated at 23 million gallons a day, which is equal to the present rate of daily use for the entire state of South Carolina. Since much of this water was conducted in lead piping, the city's population may well have been gradually poisoned by the accumulation of lead salts in their drinking water. In addition, upper-class Romans seem to have preferred lead utensils for cooking and eating purposes. One of the prolonged effects of lead-poisoning is sterility, which may account for the eventual decline of the city's ruling dynastic families.

Ancient medical writers had little knowledge of how such sicknesses developed or how disease was passed from person to person. Rome had no public hospitals, rest homes, or insane asylums. Aristocratic families patronized Greek physicians for their ailments, while persons of more modest means bought charms or potions in the Forum and prayed to the gods. Plagues such as that reported by Suetonius after the Great Fire of A.D. 64, which was said to have killed 30,000 persons, frequently decimated the city's population. After describing one such outbreak during which rotting corpses accumulated on the Tiber's banks, the historian Dionysus of Halicarnassus casually observed that those persons who drank the river water became ill afterward.

Bad water and swamps, malaria, typhoid, and other diseases were not dealt with; they were simply avoided if possible. As the primary preventative in case of a plague, the eminent physician Celsus could only recommend to his contemporaries that they *peregrinari*, or "get out of town." This did not inconvenience the city's upper classes, who could retreat to their rural villas or take a cruise, but the urban poor and especially the slaves were left to the mercy of any outbreak of disease. Due to the city's crowded conditions, they presumably fared much worse than their rural counterparts.

Rome confronted social problems no nation had ever faced before. It was one of the few ancient governments to recognize the need for environmental and social welfare. It was the first city to acknowledge an obligation to the disadvantaged, and the only one to respond to such a challenge. Distributions of meat, bread, and money to the poor were not always carried out on a regular schedule, but this type of welfare did become state policy. Basic foodstuffs, such as corn and wheat, were formally distributed through the medium of *tesserae frumentariae*, the Roman equivalent of food stamps. Other types of social assistance, such as the *alimenta*, a government program that provided a small cash allowance to the underprivileged children of the municipalities, were also implemented under the Empire.

What the Romans lacked in technology they compensated for to a large extent by their social discipline, reflected not only in urban traffic regulation and antipollution laws but also in individual behavior. The city functioned without a professional police force for more than 700 years, something that is remarkable when we consider that the Roman citizen was legally entitled to use force to defend his person and property. The ancient mind equated the quality of city life with the health and equipoise of the citizens within it, and the Roman maxim "a sound mind in a sound body" can be applied by analogy to the body politic, as well as to individuals. One of Martial's observations could still serve as a motto for modern ecologists and city dwellers: *non est vivere sed valere vita*, "life is not just being alive, but staying healthy." ■

The Bison Is Beleaguered Again

Fearful of the spread of brucellosis, cattle ranchers have declared the buffalo a menace to their industry

by Henry G. DeYoung

The American bison is perhaps the most notorious example of man's mindless and unrelenting persecution of a once plentiful animal. Only the immense size of its original domain, which stretched from California to New York and from Alaska to Mississippi, and the fierce determination of a handful of naturalists and legislators saved the bison from extermination. By the time the pogrom ended in the early twentieth century, the incredible numbers of the bison—as many as 80 or 90 million by some accounts—had been thinned to less than a thousand.

The descendants of those few survivors are found today in a number of refuges that are the primary hope for the continued existence of these massive animals. No longer able to roam the great plains, the protected herds are a vestige of what the West once was. One such herd was established in Yellowstone National Park in 1894, and millions of visitors can now glimpse a fragment from out of the country's often violent past.

It could be a reflection on the mentality of a sprawling and land-hungry young nation that one of the last groups to focus attention on the bison were the natural scientists. Working with only a relative handful of animals, the naturalists came to the conclusion that, for all its gregariousness and herd instinct, the plains bison is remarkably free of disease. Although the history of these animals includes occasional bouts with anthrax, the scale of the epidemics never approached those that ravaged cattle herds during the nineteenth century. Tuberculosis is practically unknown among the herds, and other diseases such as arthritis, cancer, ophthalmia, and the more common respiratory ailments, although observed from time to time, have never been cause for undue concern or control.

Considering the over-all good health of the bison, it is somewhat ironic that the latest threat to the species concerns disease control.

For the past thirty years, cattle ranchers in Montana, Wyoming, and Idaho have been waging a well-organized war against brucellosis, a bacterial disease of livestock that causes milk loss and abortion. During 1972, ranchers, private researchers, and the United States Department of Agriculture, spent close to $30 million in their efforts to wipe out the infection. At the same time, USDA officials and scientists have been conducting a vigorous campaign aimed at completely eradicating brucellosis from all American livestock by 1975, and the Yellowstone bison have now become a part of the growing controversy over this program. Since 1917 it has been known that the herds in the park harbor *Brucella abortus,* one of the six known *Brucella* species and the principal villain in the USDA's program. In the mid-1960s, random testing revealed the

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Ranchers fear that free-ranging Yellowstone bison will transmit brucellosis to cattle. But ecological factors, including topography, generally confine bison to the park area. Under most conditions cattle and bison herds would not intermingle.

BRADLEY SMITH; ANIMALS, ANIMALS INC.

presence of the bacterium in up to 60 percent of the park bison.

Bison infected with *Brucella abortus* seem to suffer little from it; some park veterinarians feel that the animals have acquired a natural immunity to the bacterium owing to an association that may go back millions of years.

The fear, then, is not that the bison may suffer the crippling effects of the disease, but that they may wander off the park grounds and possibly infect neighboring cattle herds. The possibility of a new epidemic cannot be taken lightly. Of all the bacterial diseases of livestock, brucellosis can be among the most disastrous, physiologically and economically.

The bacterium was first discovered in 1887 by David Bruce, who isolated *Brucella melitensis* from the milk of infected cattle and goats. Ten years later, Frederick Bang identified a new species, *B. abortus*, a ubiquitous strain that afflicts not only cattle and bison but also sheep, fowl, horses, dogs, and deer. Bang's disease becomes localized in the genitalia of the male, causing the gradual enlargement and degeneration of the peritesticular tissue; in the female, the infection is more insidious, occasionally restricting itself to the mammaries but more often spreading to the reproductive organs. If the female is pregnant (or becomes pregnant after the onset of the disease), the bacteria eventually invade the placental tissue, the vital connection between mother and fetus is disrupted, and abortion follows.

Brucella abortus is an unusually persistent organism, remaining in the body for a number of years—often with no apparent effects—to subvert subsequent pregnancies. If the disease is transmitted to man (for example, through indiscriminate handling or consumption of infected milk or meat), it is similarly retained in the system, and is the cause of undulant fever, a disease characterized by recurrent bouts of malaise, gastrointestinal disturbances, and general debilitation. The mortality rate is practically nonexistent in man, however, and the infection yields readily to such standard antibiotics as Terramycin and chloramphenicol.

In cattle, brucellosis treatment is largely preventive in nature: a vaccine known as Strain 19 is administered to heifer calves during their first six months, and the protection is lifelong. But the vaccinations are expensive and time consuming, and cattlemen look forward to the day when they can be eliminated entirely. Determined to hasten that day, a group of ranchers, with USDA backing, descended on Yellowstone National Park in March, 1972, with their proposed solution: round up all 700 park bison, inspect them for brucellosis, destroy the infected individuals, and return the rest to the park. Bison that could not be rounded up would be shot, and the last known active reservoir of brucellosis in the country would thus be eliminated.

While the ranchers' zeal can be at least partially understood, it is doubtful whether they or the Department of Agriculture fully appreciate the implications of their proposal. Yellowstone National Park spreads out over nearly 3,500 square miles of meadows, dense forest, and rocky, forbidding wilderness, and the roundup would be a

J. SIMON; BRUCE COLEMAN INC.

E.R. DEGGINGER

A Herculean and perhaps impossible control program would be required to eradicate Brucella *bacteria. Known carriers include not only the Yellowstone bison, top; cattle ticks, center; and elk, bottom; but also rodents, flies, and probably many others.*

HARRY ENGELS

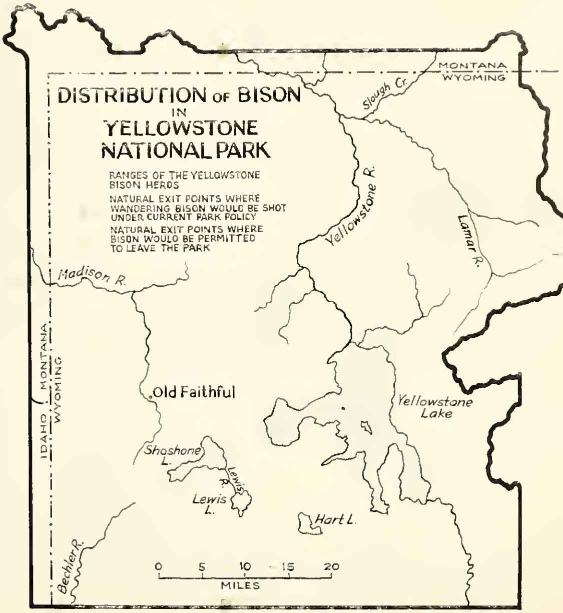
staggering job, lasting several years. At that, according to park biologist Dr. Mary Meagher, no more than three-quarters of the bison could be located, let alone trapped, even under the most favorable conditions. Furthermore, during the period from late autumn to early spring, some 80 percent of the bison move to remote wintering areas inaccessible by land, thus precluding effective trapping.

A second limitation is even more portentous. Once penned, even briefly, bison become essentially domesticated very quickly, and rarely return to their free-ranging habits. This was vividly demonstrated by a similar brucellosis-control program on southern Montana's Crow Reservation a few years ago.

A failure to return to the wild would constitute more than an esthetic loss. The ecology of Yellowstone, like that of any large, untamed area, is a delicate, immensely complicated network of interdependent and obscure relationships: while predators rarely attack bison in the winter months, a starving wolf will attack a weak or sickly calf immobilized by the ice and snow. Bears are also reluctant to take their chances against the ferocity—and the horns—of an aroused bull, but a huge grizzly, weighing in at 1,200 pounds or more, will occasionally descend on a small, unprotected herd.

In addition to their minor role as a prey species, dead bison become carrion for a wide variety of scavengers such as coyotes, bears emerging from hibernation, bald eagles, magpies, and ravens. A constant companion of bison, the cowbird, or "buffalo bird," exists to a significant extent on the innumerable insects that become entangled in the bison's shaggy coat.

The ranchers' proposed solution is apparently based on the belief that bison migrate—that is, that they instinctively or deliberately travel hundreds or even thousands of miles in search of better food or more hospitable climes. Historical references to these mass movements notwithstanding, contemporary studies indicate that these migrations are actually random wanderings and that few animals move any appreciable distance from their native grounds. Bison, however, have been known to move north out of Texas and Oklahoma to escape the blistering southern summers, and an unusually severe Wyoming winter may prompt individual searches for better feeding areas.


DISTRIBUTION OF BISON IN YELLOWSTONE NATIONAL PARK
RANGES OF THE YELLOWSTONE BISON HERDS
NATURAL EXIT POINTS WHERE WANDERING BISON WOULD BE SHOT UNDER CURRENT PARK POLICY
NATURAL EXIT POINTS WHERE BISON WOULD BE PERMITTED TO LEAVE THE PARK
MONTANA
WYOMING
Slough Cr.
Yellowstone R.
Lamar R.
Madison R.
IDAHO
MONTANA
WYOMING
Old Faithful
Yellowstone Lake
Shoshone L.
Lewis R.
Lewis L.
Hart L.
Bechler R.
0
5
10
15
20
MILES

In anticipation of mounting pressure from cattlemen, the National Park Service in 1971 instituted a program to contain bison within the confines of Yellowstone. Bison leaving the park at points where they might come into contact with livestock would either be hazed back into the park or shot.

It is also highly unlikely that bison would deliberately mingle with domestic cattle. While the bison is a gregarious animal, its sociability is largely limited to its own species. A search for better water in the summer or for less forbidding snowdrifts in winter may bring an individual bison in contact with a local cattle herd, but such a meeting is one of pure chance.

The officials of Yellowstone National Park are not inclined to brush off the matter, however. It is simply impossible to ignore the potential economic, social, and political force of so organized a group as the livestock interests; nor can the Interior Department afford to turn a deaf ear to an issue that could be popularly interpreted as a real and substantial threat to the well-being of the country.

In anticipation of the ranchers' demands, Yellowstone personnel came up with a program of their own. Since there was no pressure to eliminate brucellosis from park bison, only to keep the bison from transmitting the disease to cattle, there was no need to destroy even a single bison—the bison just had to be kept within the park boundaries. To this end, park biologists determined that if a bison was inclined to leave the park, it would do so at one of nine "exit points": one on

FRAN ALLAN, ANIMALS, ANIMALS INC

the eastern border, one on the west, four on the north, and three on the south. These exit points are locations where bison have previously been seen either leaving the park or wandering in the area of the boundary. Areas between exit points may simply be impassable or inconvenient for bison movement. Of these nine exits, five are situated relatively close to established cattle herds. Bison seen at or near these points would be hazed back into the park or, failing this, would be shot by park personnel. It was estimated that no more than three or four bison per year would fall victim to this policy and, in fact, not one has been destroyed in the two years the program has been in effect.

But the ranchers and their backers remain adamant. They argue that bison are big enough to go where they want, and that there is no foolproof way of monitoring their movements. They are right, of course, because no one really knows how many individual bison are in the park at any given time, or how many may be wandering in the vicinity of the borders.

Sixty percent of the 700 bison in Yellowstone National Park are known carriers of Brucella abortus, *but the animals, including the young, apparently suffer no harmful effects. There are no known cases of bison transmitting the disease to livestock.*

As of this writing, no acceptable solution to the controversy has been found. According to some sources, something of a battle is shaping up between the Departments of Agriculture and the Interior over the bison, and the implication is that the issue may take on political tones. Agriculture, after all, has no authority to enforce its program within Yellowstone; at the same time, Interior has no desire to go on record as opposing Agriculture's brucellosis eradication program.

As the charges and countercharges are bandied back and forth,

a few pertinent facts seem to have gone by the boards. First, and perhaps most important, many bacteriologists seriously doubt that brucellosis can ever be wiped out. Carriers include not only bison and domestic stock but also elk, rodents, flies, and ticks—species that are obviously out of reach of even the most zealous eradication program. As long as such hosts remain in possible contact with cattle, it is difficult to see how Agriculture will ever be able to talk seriously about getting rid of brucellosis and other bacterial diseases.

Second, it is assumed, not proved, that bison can transmit active *Brucella* bacteria to domestic cattle. No such case has ever been reported, although research into this possibility is being continued. At any rate, the areas surrounding Yellowstone National Park have not reported a single case of brucellosis in more than ten years.

As for bison leaving the park, in the past ten years there have been fewer than 75 known cases. Most of these involved bulls—"nonreactors," for all practical purposes since females are the prime transmitters of brucellosis—and none occurred in the so-called critical areas.

Ranchers, of course, are wary of anything that may adversely affect either their herds or their bank accounts: cattle are big business, and cattlemen are businessmen. And it is natural for the Department of Agriculture to insist on stringent disease inspection and control of livestock: the efficient fulfillment of this role is a significant part of its responsibility. At the same time, the controversy seems to have moved beyond the question of public health into the far less precise arena of esthetics versus economics: the real issues have become slippery and obscure.

It isn't difficult, or by any means alarmist, to envision the logical extension of the cattlemen's position. Bison, after all, are only the most immediately obvious villains; elk, mountain sheep, wolves, coyotes, and scavenger birds such as eagles, vultures, and magpies are also actual or potential *Brucella* hosts. If brucellosis and other naturally occurring bacteria are to be wiped out, the effective destruction of all possible carriers would have to be accomplished. Widespread trapping and poisoning of wildlife could be a feature of the next control program. How do we ask ourselves, "Where does it stop?"

The cattlemen have bothered themselves with only one question: "How can we protect our financial investments, at any cost?" Their solution is an overly simple one. But any solution—if it can first be proved that a need for one exists—will have to be framed within a broader context. The American public has a vested interest in this situation, a part of its heritage and its natural resources are at stake. The outcome of the controversy over 700 bison will be vital, for it is likely to have a lasting effect on wildlife and national park use policies for years to come. ■

JEN AND DES BARTLETT: BRUCE COLEMAN INC

Folk Art in the Barrios

Following a boy's death, colorful murals depicting Chicano unity cover some of Santa Fe's adobe walls

by Eric Kroll

Man's need to communicate can take many forms other than the written or spoken word. Today, with innumerable factions trying to make themselves heard, the trend is toward instant communication and immediate impact. Consequently, many people are turning to music, art, cinema, and television to get their message across.

In Santa Fe, New Mexico, a group of folk artists, Los Artes Guadalupanos de Aztlan, are creating bright murals on the walls of the barrios—murals that express the sentiments of the radical Chicano youth of the community. The dazzling colors and exaggerated figures of these wall paintings portray the past glory of the Aztec ancestors of the Chicanos, the repression and discrimination of the present, and the hopes for the future. Whereas words can be easily ignored, murals painted outdoors on walls are not easily dismissed or overlooked.

Los Artes discovered their medium of communication in 1970, when 12-year-old George Leyba died of a drug overdose. Shortly after, his three older brothers, Carlo, Albert, and Sammy, painted a memorial mural on one wall of a Santa Fe playground. It is a child's idealized view of Africa, reminiscent of Walt Disney. In a Garden of Eden setting, lions laze beneath a tree from which monkeys swing. In the distance, elephants amble and an impala gazes majestically about. But this pastoral mural lacks the elements of protest that dominate those that followed.

This first mural was received with enthusiasm by the Chicano community; its popularity encouraged the Leyba brothers to paint other murals that expressed their frustration and anger at a society that they felt had contributed to the death of their younger brother and had subjugated millions of Chicanos.

Under the auspices of a local methadone maintenance center, and aided by a grant from the Office of Economic Opportunity, the Leybas, joined by two other youths, Geronimo Gardunio and Gilberto Guzman, participated in a six-week experiment in mural painting. The six-week period is now long past, but the members of Los Artes continue to paint murals, supporting themselves through odd jobs and contributions.

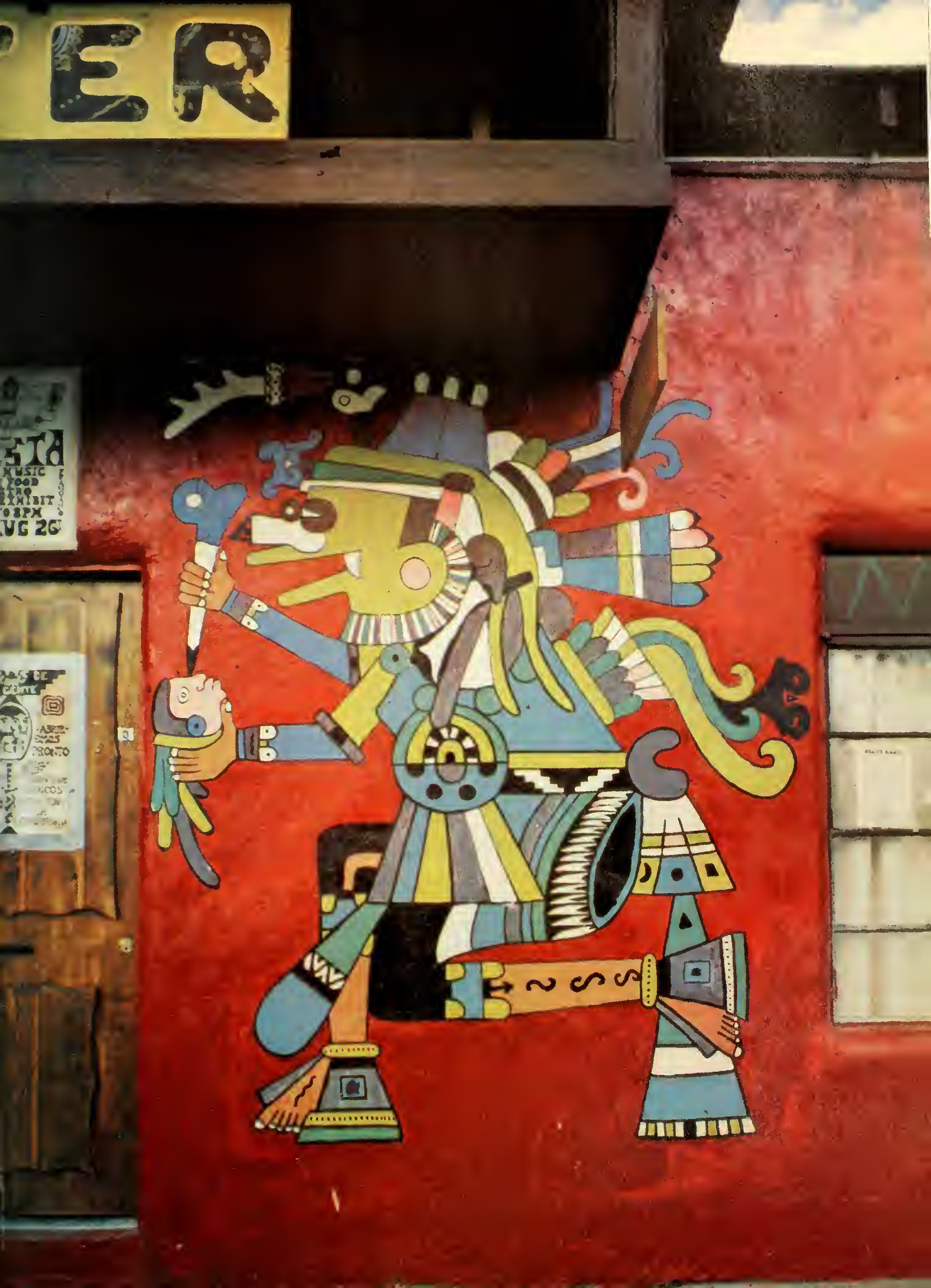
On ten Santa Fe walls, the history of the Chicanos, both mythical and actual, is depicted in brilliant colors and disproportionate figures. Aztec medicine figures dance and gods protect peasants, all for the glory of the Chicano in the present. On some walls, the chains of bondage are being broken and the Lady of Justice, depicted as an Indian maiden, watches over both Indians and Chicanos. On others, Pancho Villa and Father Hidalgo lead the Mexican peasants to freedom. But the clenched fist at the end of grotesquely muscled arms is the most predominant image. It symbolizes unity, determination, ambition, and pride, all traits that Los Artes believe should be a part of Chicano psychology. The figures they paint are bold, upright, strong, and grasping, far from the stereotype of the Mexican-American with drooping moustache and floppy sombrero lying in the shade of a stucco building.

Members of Los Artes, as do many others, refer to themselves as "Chicanos" rather than as Mexican-Americans or Spanish-Americans, terms they feel are removed and condescending. Through the medium of their large, brightly colored murals, these folk artists are trying to express the anguish felt by the Chicanos after hundreds of years of repression and degradation. The viewer can see the chains of bondage being broken, a stake being driven through the heart of a prone Indian, or marching skeletons dressed in army fatigues throwing hand grenades. In the huge figures with their exaggerated movements, he can see spots of humor. And he can also see the quiet determination, the unbroken spirit, and the sometimes youthful naïveté of the murals' creators. However the viewer interprets them, the murals serve as reminders of the past and as hopeful portents of the future.

Obvious to all is the effect of the murals on the barrios where most of them have been painted. The outskirts of Santa Fe consist of a patchwork of square, one- or two-story buildings, all of the same red-brown color. Blank walls are numerous; the streets are narrow and dusty. Under the

A painting of a mythical Aztec god flanks the doorway to a Santa Fe medical clinic.

ALL PHOTOGRAPHS—ERIC KROLL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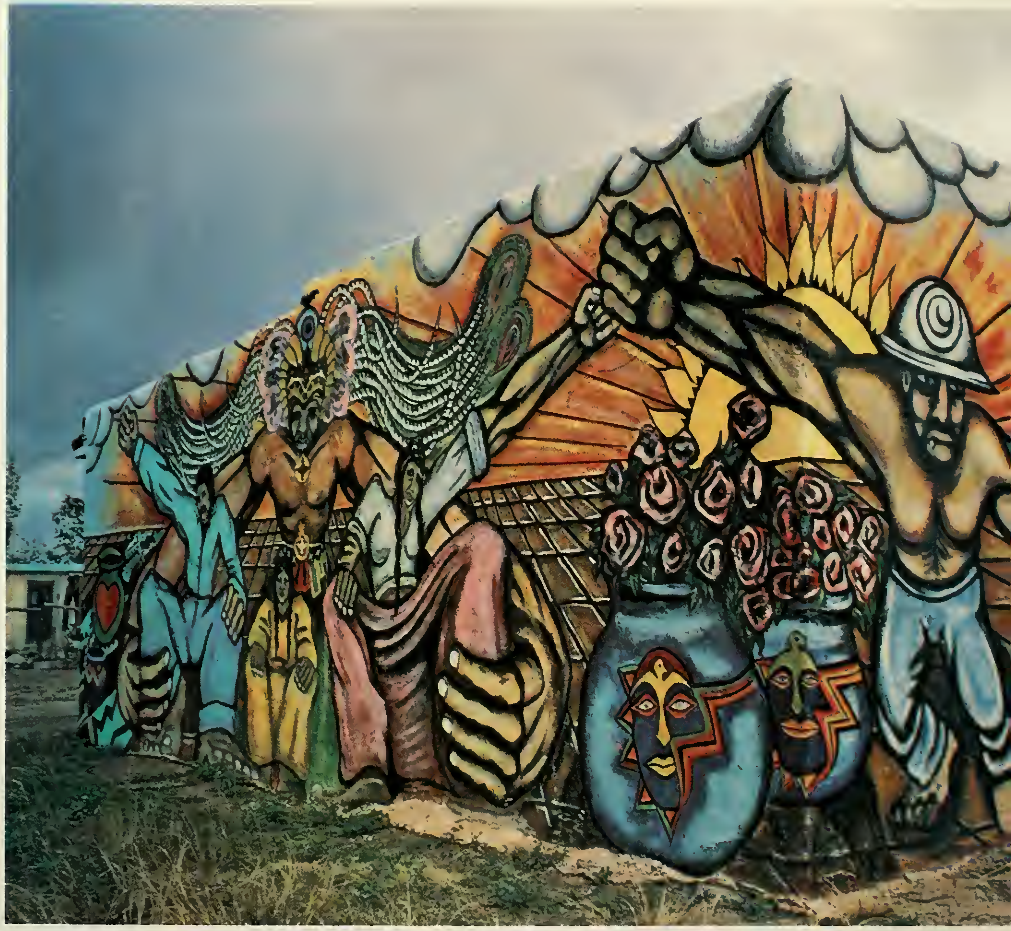
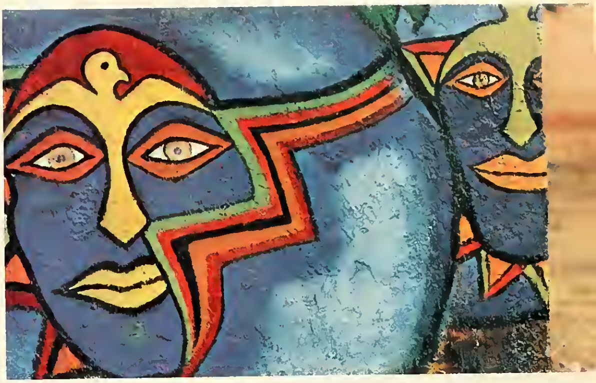
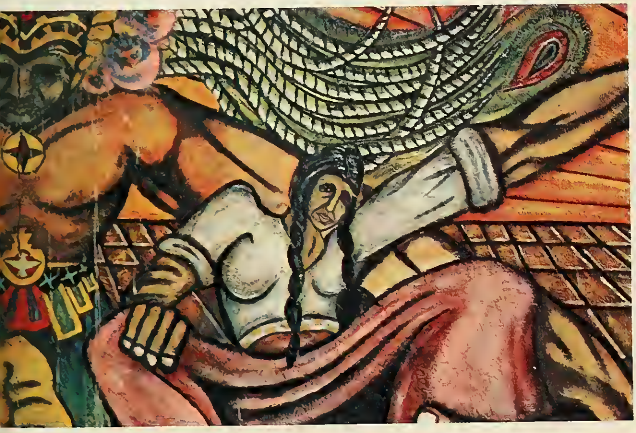
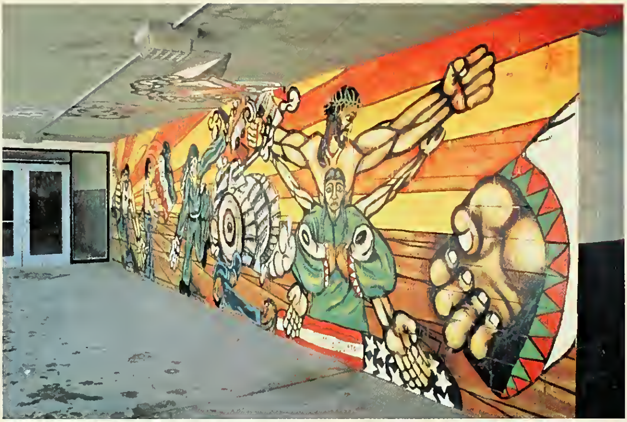
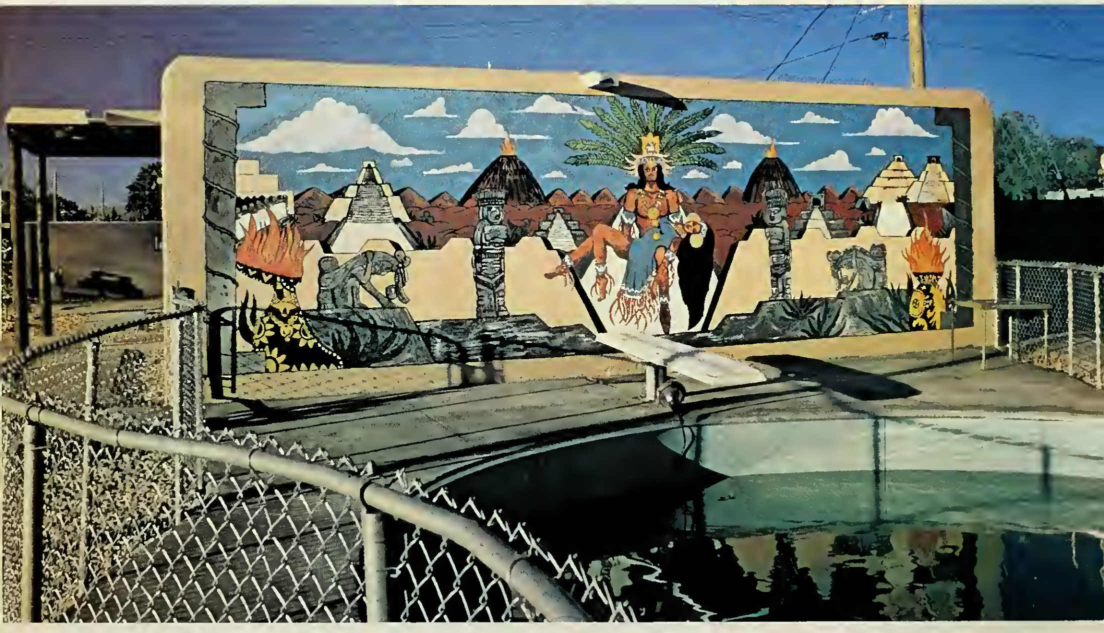


This mural covers two walls of a home in Santa Fe. Between the figure of an Aztec god protecting peasants, at left, and a religious figure, at right, a muscular Chicano clenches one fist, a Chicano sign of unity. In his other hand, he clutches a book, "Viva La Raza." Details of the mural appear at right.



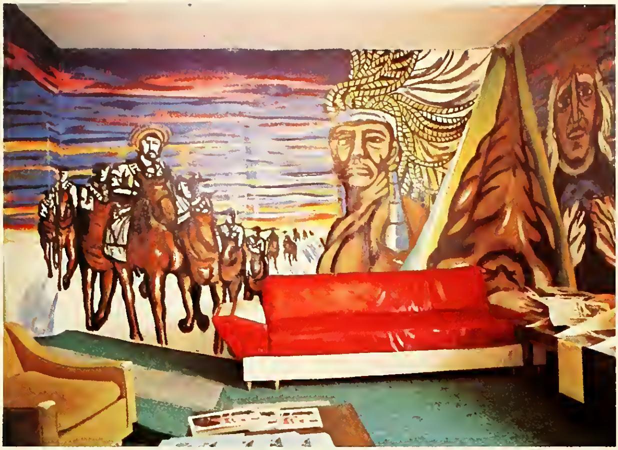


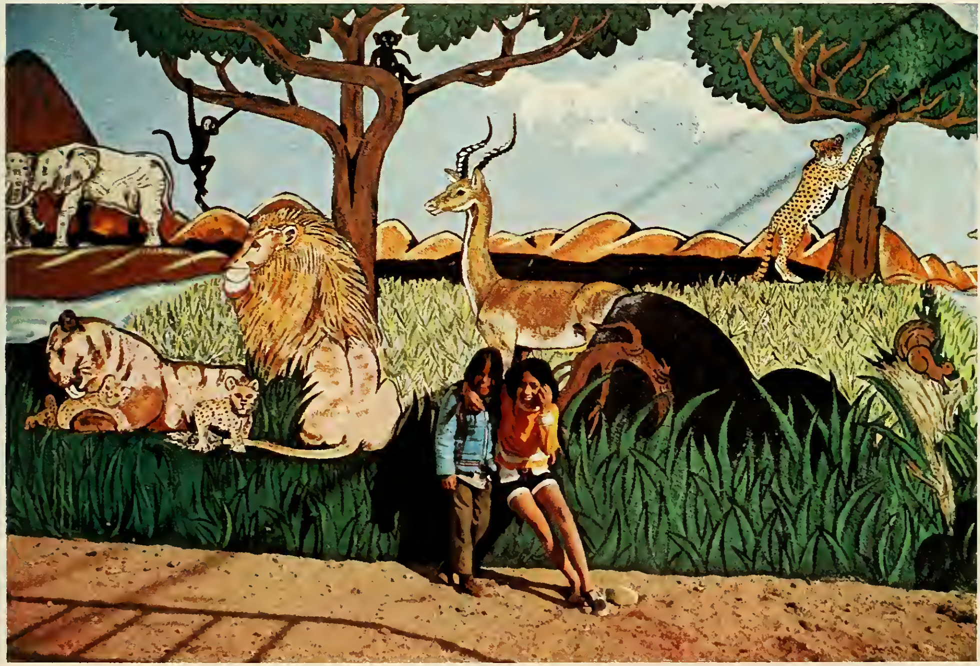


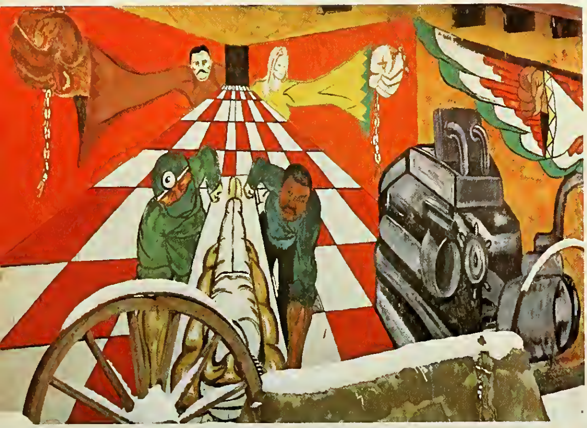


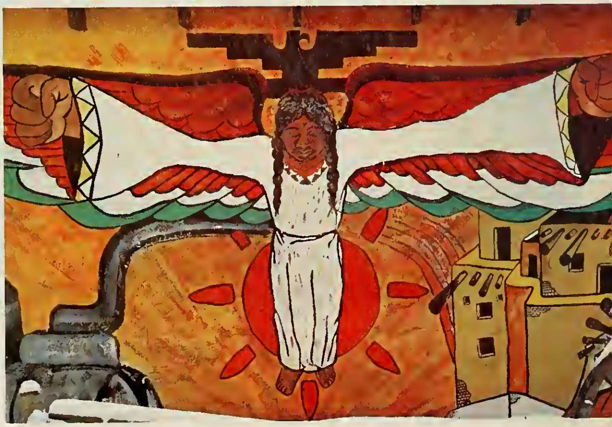
Protesting the Vietnam war, a mural on the wall of a Santa Fe high school, top, depicts skeletons dressed in army fatigues throwing hand grenades. Below, imagined scenes from Aztec life were painted as a background for a swimming pool. In the center of this mural an Aztec priest is about to sacrifice a maiden.

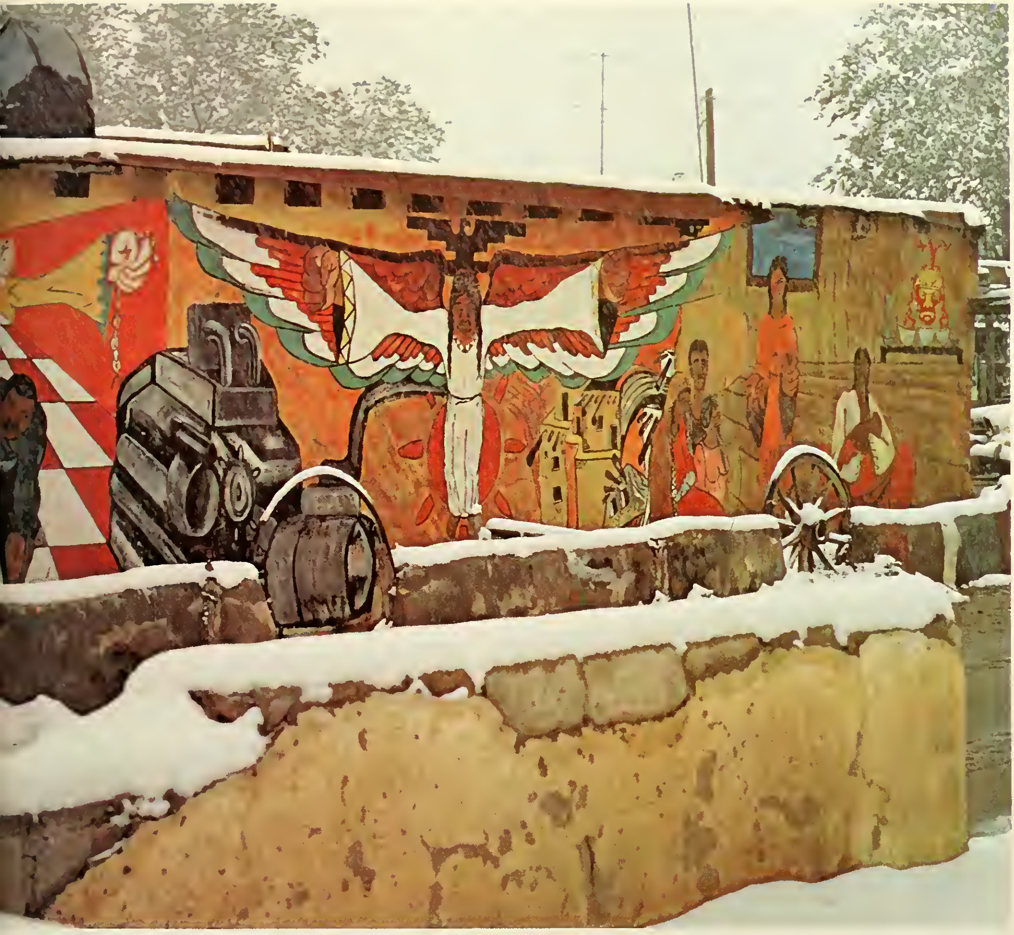
In a medical clinic waiting room, below, wall paintings glorify heroes of the Mexican Revolution. On the left side of the mural, Pancho Villa leads his troops; on the right, Father Hidalgo holds the chains of bondage. At bottom, the memorial mural to 12-year-old George Leyba brightens the wall of a playground.





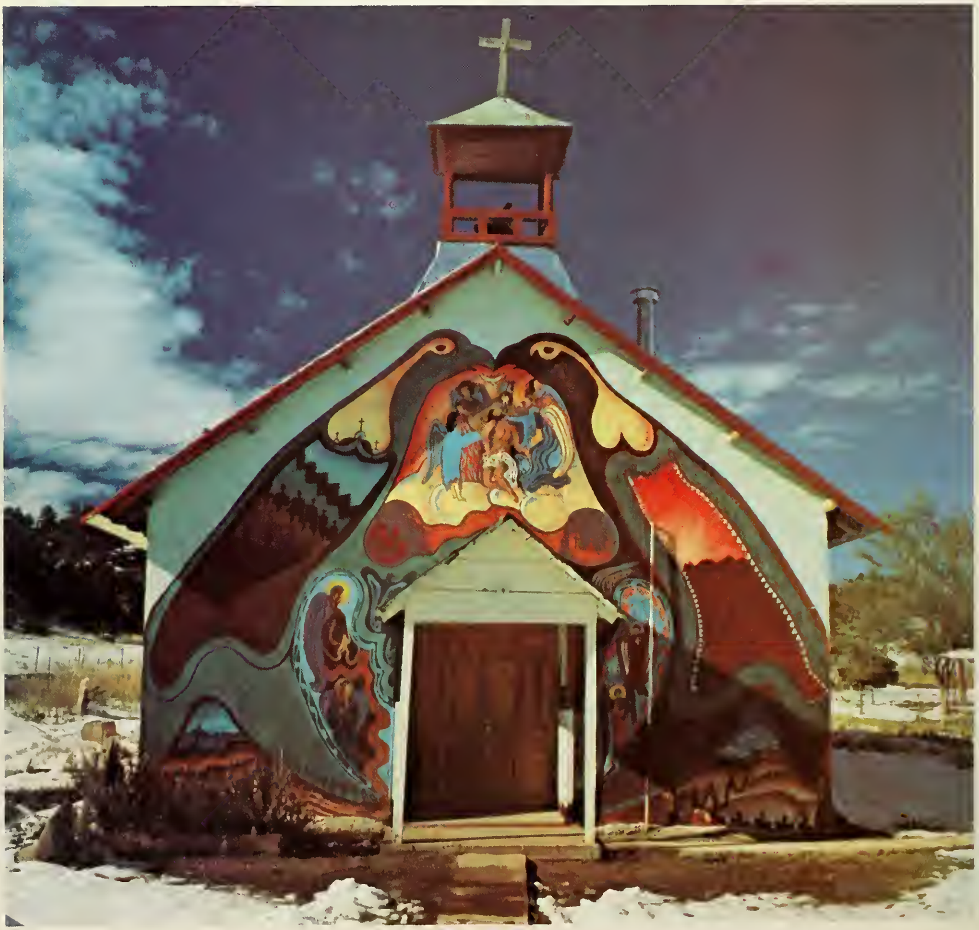






A painting on an outside wall of a medical clinic depicts a Chicano doctor and an Indian wheeling a patient into an operating room. Patients are looked after by a winged Indian maiden dressed as a nurse.
Details of the mural appear at left.

On a church in El Llano, a town just outside of Santa Fe, two doves are depicted encircling an ascending Christ who is supported by angels. The mural was painted several years ago by a group of Chicano youths not connected with Los Artes, thus suggesting that mural painting is not a new form of expression for Chicanos.



hot midday sun, the proximity of the Sangre de Christo Mountains to the northeast offers little solace; and the dry plains to the west are only a huge emptiness that exaggerates the fragility of the small adobe buildings. In this setting, the brightness of the murals strongly offsets the sameness of the angular buildings, and gives the surrounding area an air of hope and expectation.

For the Chicanos and Indians who live in the barrios, however, the murals do more. They reflect the antagonism many Chicanos feel toward a society that has not offered them education, that discriminates against them in employment, and that does not give them equal rights. The determination seen in the murals stems from years of harassment, the influx of drugs, the stares of tourists, and the sneers of bureaucrats.

Like other creators of folk art, and unlike most professional artists, members of Los Artes do not sign their work and will not divulge who painted specific murals. Of the five members of the group, only Sammy Leyba and Geronimo Gardunio have had any formal training. Both attended art classes for a short time, but dropped out because they did not agree with the structured routine.

Instead of entering the highly competitive art world, they have chosen, for the present, to be the voices of the radical elements of the Chicano community. They have painted on the walls of Chicano-owned buildings in the Santa Fe slum area, as well as on the walls of a high school and a health clinic. Soon after painting their first outdoor mural, Los Artes received numerous requests to paint murals in private homes and in private institutions, requests which they refused, insisting that art should not be only the property of the rich.

In their antagonism toward private art and art galleries, Los Artes upset the traditional and well-populated Santa Fe art community early in 1972 when they were permitted to paint a mural on the walls of a tool shed on Canyon Road, in the heart of the tourist-filled art gallery district. It was a symbolic mural showing the Lady of Justice as an Indian maiden breaking the chains of bondage from an enslaved and well-muscled Chicano. To the business community it was an embarrassment; to the art galleries it was a threat; but for the Chicanos, it was their way of showing not only their innate creativity but also their attitude toward private art. The disputes that followed only highlighted the cause of Los Artes, and the flow of tourists did not diminish. On the contrary they found the mural attractive. In time, the issue simmered down and the complaints died.

To set an example for other Chicanos is another aim of Los Artes. Murals are painted on walls of the Chicano neighborhoods in the hope that latent Chicano creativity, especially in children, will surface. Los Artes believe that the potential for both creativity and freedom lies behind the adobe walls. They wish the murals to be an empirical way for children to realize that they, too, can learn to express themselves. The group plans to hold art classes for the neighborhood children, and already some children have begun to paint their own murals.

The style of Los Artes flows from the work of such famous twentieth-century Mexican muralists as Diego Rivera, José Clemente Orozco, and David Alfaro Siqueiros, artists who concentrated on the turmoil between men, the resultant social injustices, and the hope of eventual harmony. Their emphasis, however, was on the universal, while the work of Los Artes is limited to what pertains to Chicanos.

The murals of Los Artes can be interpreted as a type of graffiti, but unlike most graffiti, they are not quickly administered in the quiet of night with a spray can of paint or a magic marker. The artists are not apologizing for their means of communication; rather, the details, the colors, and the symbolism reflect their pride and conviction. They chose this medium as their manner of protest: they show the Chicano not only as he was and is, but also as he can be. And in their format and setting, the murals and the message are unavoidable, they must be seen; the viewer can turn away from them, but he cannot turn them off.

Foiling the Falconers

A hardy band of amateur naturalists
play midwife to an endangered bird of prey

by Alan Pistorius

On April 19, 1972, my wife and I set up a tent camp on top of a remote cliff just out of sight of San Francisco Bay. On June 15 we took it down. During the intervening eight-week period, thirty adults, four children, and three dogs spent, among them, nearly 1,400 consecutive hours in that camp and drove almost 3,000 miles getting there and back. This expenditure of time and energy was aimed, not at establishing some sort of cliff-sitting record, but at seeing that a clutch of prairie falcons fledged from that hill.

The plan for a vigil had its beginnings during the previous winter when we learned that this aerie had been robbed by falconers on a regular basis for a number of years. The prairie falcon's virtual absence in coastal California, its range-wide decline, and the threat of a $1,000 fine and a year's imprisonment for taking one of these birds had not deterred the nest robbers.

Regional Parks people we talked to were concerned about the situation, but they did not have the means or the authority to deal with the situation. Under consideration by one agency, we learned, was a plan to dynamite the aerie in hopes that the birds would find another, presumably less vulnerable, nesting site. This seemed a desperate measure at best, and we felt there had to be a better way to afford the falcons nesting protection. Through a process of elimination, we arrived at the notion of a continuous watch, guarding the aerie during the eight-week period from shortly before the hatching of the eggs until the young were strong fliers.

Setting up a round-the-clock watch is theoretically simple. You start with someone sufficiently free (and crazy, we increasingly muttered as the spring progressed) to coordinate the project; that is, somebody able to spend half his life on watch and the other half on the phone. Next you need people willing and able to spend a weekend or a 60-hour weekday stretch off in the wilds. Finally, you need a certain amount of matériel and a method of transporting it and people into difficult areas. We had our tent, and the Regional Parks administration loaned us a table, a five-gallon water can, a portable john, and provided a four-wheel-drive vehicle and a driver for changing the guard.

People, of course, are the key to any such endeavor. Finding interested individuals is no problem; getting them committed to 48- or 60-hour watches is often another matter. Our best support came from several friends who were either between jobs or out of jobs, with additional help from students, housewives, teachers, and a reserve warden—people with little in common except the conviction that these prairie falcons, like other wild animals, ought to have the opportunity to live free and perpetuate their kind.

One of our first problems concerned the necessity of rigging up some method of communication with the outside world in the event that help had to be summoned. We started with World War I field phones donated by a government agency, and several of us strung miles of phone line to the nearest inhabited residence. We cranked up the old relics, and they actually worked. Once. Checking later, we found that the line had been cut in a number of places, so that plan was dead. The California Department of Fish and Game, which cooperated with us from the beginning, then supplied us with two walkie-talkies. They worked fine if anybody happened to be on the other end, which they usually weren't. We finally acquired a nautical air horn, which, besides deafening the watcher, could be heard at the only occupied residence within five miles, provided the wind was right.

In short, we were pretty much on our own up there, and that was fine with everybody. As one woman watcher wrote in the log a week after we established the camp:

> *April 26*: A peaceful afternoon with no intruders. After 30 years of married life and 3 kids, it's a forgotten experience to be *really* alone. . . .
>
> *April 27*: 7:00 A.M. The telephone does not work—which is okay by me. A perfect climate this morning and the place is *lousy* with bird song!

Most of the volunteers were experienced birders, and the area around the cliff must have been

Prairie falcons fledge six weeks after hatching, but the young birds remain vulnerable to nest robbers until they are strong fliers.

RON AUSTIN, NATIONAL AUDUBON SOCIETY

A fast and graceful aerial acrobat, the prairie falcon will drive other falcons and even eagles from its territory by repeatedly diving at them.

studied as intensively as any in the history of field ornithology. By the end of the watch more than ninety species had been identified, a remarkable total for this semiarid range country. Along with the falcons, cliff swallows, white-throated swifts, house finches, and a pair each of Say's phoebes, canyon wrens, and sparrow hawks were breeding on the cliff face. Because the limited number of trees tended to concentrate the arboreal-nesting birds, their nests were relatively easy to locate. A spot was discovered from which a seated viewer could follow the activities at six different nests belonging to five species: Bullock's oriole, house finch, chipping sparrow, western kingbird, and Lawrence's goldfinch.

Two weekend watchers brought their children along; the comments of two of their 10-year-olds add an interesting perspective to the notes on wildlife that fill the log:

> *May 13*: In the night we saw tons of bats. Wev'e tried to catch lots of lizards. There to fast. No snakes. Where are they? The best thing we saw is the falcon. We've seen lots of swallows. Paragreen falcons are neet. Also tons of turkey vulture. The toliet is wonderful. [This has to be the best line in the log, although I'm sure other watchers would dispute its accuracy; while the "toliet," a ring on four legs, offered a magnificent view, it tended to unsteadiness, was nestled in poison oak, and the bags were known to leak.] Down in the valley . . . theres a huge oak tree—its great for climbing. We just saw a baby rattleler. It has two rattles. Its cute.

The stillness of the nights was occasionally punctuated by the gunfire of "spotlighting" hunters, cruising a distant but visible back road. One pair of watchers out before sunrise looked on helplessly as two men fired thirteen shots from their car, then returned from a draw dragging a deer. Shortly after midnight the next morning a warden arrested two men on the same road in a similar car with a freshly shot gray fox. A depressing and frustrating business and, as the wardens know, all too common.

Our main business, of course, was to protect the nesting falcons. Underground falconers were clearly itching to get at the birds. Before the watch even began, Fish and Game personnel had ripped out the posts that some falconers had driven into the cliff for the purpose of anchoring their climbing ropes. The openness and arrogance of it was galling, and some watchers longed to do battle with the dastards. As one watcher wrote of his first night:

> *April 28*: Lovely evening, clear and calm, with a glorious near-full moon, attractive as well no doubt to adventurous, villainous nest robbers. None took advantage of the light, however, so I was unable to test my idea of myself as being as brave, fearless, bold, etc., as the old Audubon wardens who took on the plume hunters 60-odd years ago.

While awaiting the opportunity to validate our heroic self-images, we watched the falcons. Close observation was difficult; the nest itself was invisible from above and below, and we avoided the immediate cliff top area so that we wouldn't distress the birds. Perhaps a hundred hours of watching would produce an observation like the one made on April 22, when both parents attacked a third, intruding prairie falcon, driving it over a peak two miles away in seconds. Here are several other observations of behavioral interest from the log.

> *May 11*: 8:40 A.M. Saw the male bring a ground squirrel to his mate on the cliff face. She flew off with it in her talons to a [plucking] rock in the grass and brought it back to the nest, sans tail and probably sans skin (looked smaller). After the young had had their fill, she took the remains to her rock and took quite a while finishing it off. [The falcons habitually fed at several "plucking

RON AUSTIN, NATIONAL AUDUBON SOCIETY

rocks" located a half-mile down the canyon from the cliff face: they also regurgitated pellets here.]

May 17: After a few sorties out and back again, the falcons began a cyclic series. One of the pair would glide up in a high arch, then dive at mate, which received diver by turning on its back with talons raised. Did not see actual jolt of contact at any time but heard scream at instant of possible contact. The diver then rose again high up to begin cycle again. This complete cycle happened at least 20 times.

June 1: Just heard a falcon that sounded upset. It turned out that an immature golden eagle was cruising too close for her comfort. She dived on it several times until it retreated to the east.

No prey capture was seen, since the falcons did not hunt in the immediate area of the nest. They would fly off down valleys in several directions, returning from ten minutes to an hour later with a California ground squirrel or a meadowlark. These, together with an occasional scrub jay, seem to have formed almost the exclusive diet of the falcons. Before being taken to the nest the ground squirrels were beheaded and degutted at the plucking rocks; as the young matured, all prey was taken in whole and the young did their own butchering.

In mid-May the watch took a somber turn. The news of the robbery of the peregrine falcon nest at Morro Bay, California, broke, gaining national notoriety. It was discovered on May 9 that the peregrine aerie, one of only a handful in California, had been robbed of its chicks at night by men utilizing sophisticated climbing equipment and two-way radios. California Fish and Game put pressure on the California Hawking Club, the parent organization of many California falconers on both sides of the law, and both chicks were dropped off under cover of darkness at a predetermined place. The chicks were returned to the nest, and were being fed by the parents the next day.

Two days later, however, the young were stolen again. Four young men were arrested, but this time the birds were gone for good. Shortly after these incidents, several men arrested in connection with that robbery were identified in the area of our watch; it looked like we were next. At that point the prairie chicks were about three weeks old; we expected them to fledge at about six weeks, so the next three weeks were crucial. The nest was checked by rope, for the first and last time, to make sure everything was going well. In it were five handsome, healthy chicks. Fish and Game, which until then had been giving us moral support, determined at this point to give us an armed warden during night watch until the young left the nest niche. This was an ideal setup; we could get some sleep without jeopardizing round-the-clock vigilance.

Watchers slept, but not always soundly, and the dreams recorded in the log often reflect doubts and concerns about the watch.

May 31: This morning I dreamed I woke and the entire meadow below the tent was filled with little two-man pup tents . . . each lined up in perfect rows and holding a pair of officially dressed cub scouts. They were just emerging and lining up for an early morning cliff-climbing workshop—over the falcon cliff.

April 28: Dreamed of falcons which could transform themselves into beautiful, graceful women and back again at will, and kept themselves perpetually young by doing so. For the opportunity of being reborn, however, they had to pass through an egg stage, and more often than not, careless nest robbers would break the eggs and they'd die. Whew!!

On the evening of June 7, when the chicks were about six weeks old, we had the first indication that they were about to fledge. I was watching both adults outlined on the profile of the cliff face when suddenly a pair of furiously beating wings appeared behind one of them. One young, at least, had left the nest. The next day four young could be seen from below the cliff, hopping about on the cliff face, exercising their wings (which they did by facing *into* the cliff and flailing away), and crying for food. The weather turned bad, however, and the first real flights were not recorded until a few days later.

June 10: At approximately 10:00 A.M. I went down to the trees around the bottom of the cliff to try to see the fledglings. I spotted two on a wide outcropping and a third some 30 feet away. Then another one appeared above the first two, and half-fell, half-flew down to join the pair on the outcropping. About then the female appeared and teased the fifth bird into flying 30 feet over to join the other four, and left what I presume to be a ground squirrel. Shortly after that the male appeared, and after four or five flights in front of the young he dropped a small bird. With an explosion of feathers when the young got to it, he was off.

There was an anxious moment two days later when a young falcon had an accident that could have resulted in serious injury had not the watch seen it occur.

June 12: An immature prairie came flying over the cliff . . . and caught a wing on some coiled barbed wire and hit the dirt. I ran quickly down to see what I could do while Rita ran back for something with which to wrap the bird in the event we had to handle it. . . . When I got to it, the bird spread its wings in defense posture, lay back into the barbed wire and opened its mouth to give a soft, continuous hiss. . . . I stepped back and it stood up. I moved away to relieve the threat of my presence. The bird jumped *through* a loop of barbed wire, tearing out a few downy feathers, and leaped off the cliff and flew out and down out of sight.

The World War I-style concertina wire, strung on the lip of the cliff top midway through the watch, was a well-intended but ill-conceived plan (it could be easily circumvented or roped over) devised by somebody in Fish and Game to deter nest robbers. This incident reinforced the notion most of us had had from the beginning: you cannot rely on electronic gadgets, barriers, or traps to protect cliff-nesting birds (although tree-nesting raptors such as eagles and ospreys can be, and in parts of England are, protected in this manner). Only continuous human vigilance can hope to succeed.

Fortunately, the young falcon seemed to have suffered no lasting injury from its experience. On June 14 we were able to locate all seven birds on the cliff at one time, and all the young were flying strongly and looking perfectly fit.

On the afternoon of June 15, we took the tent down. Considering that it had probably had the equivalent of a lifetime's use that season, it was in surprisingly good shape (except for two pull-ties, one of which had been shredded early in the spring by an oriole desperate for building material; the other had been chewed up by a deer mouse who danced nightly atop the tent). During the course of the eight-week period, well over a hundred people—mostly hikers—were evicted from the critical area. Our defenses apparently seemed adequate to the falconers, however; no direct attempt was made on the nest.

The round-the-clock watch had come to an end, but the vigil had not. Periodically during the summer, while the young remained vulnerable to livetrapping, volunteers spent their days on the hill.

The watch continues this spring under other coordination: it cannot hope to be luckier than the first. The odds are against such a large clutch of eggs all hatching, and then all young living to fledge. Even if the odds catch up with these falcons, and three birds are lost—to livetrapping, to accident or disease, to some idiot with a gun—two birds will likely survive to begin a new breeding cycle on a cliff face somewhere in the hills of central California.

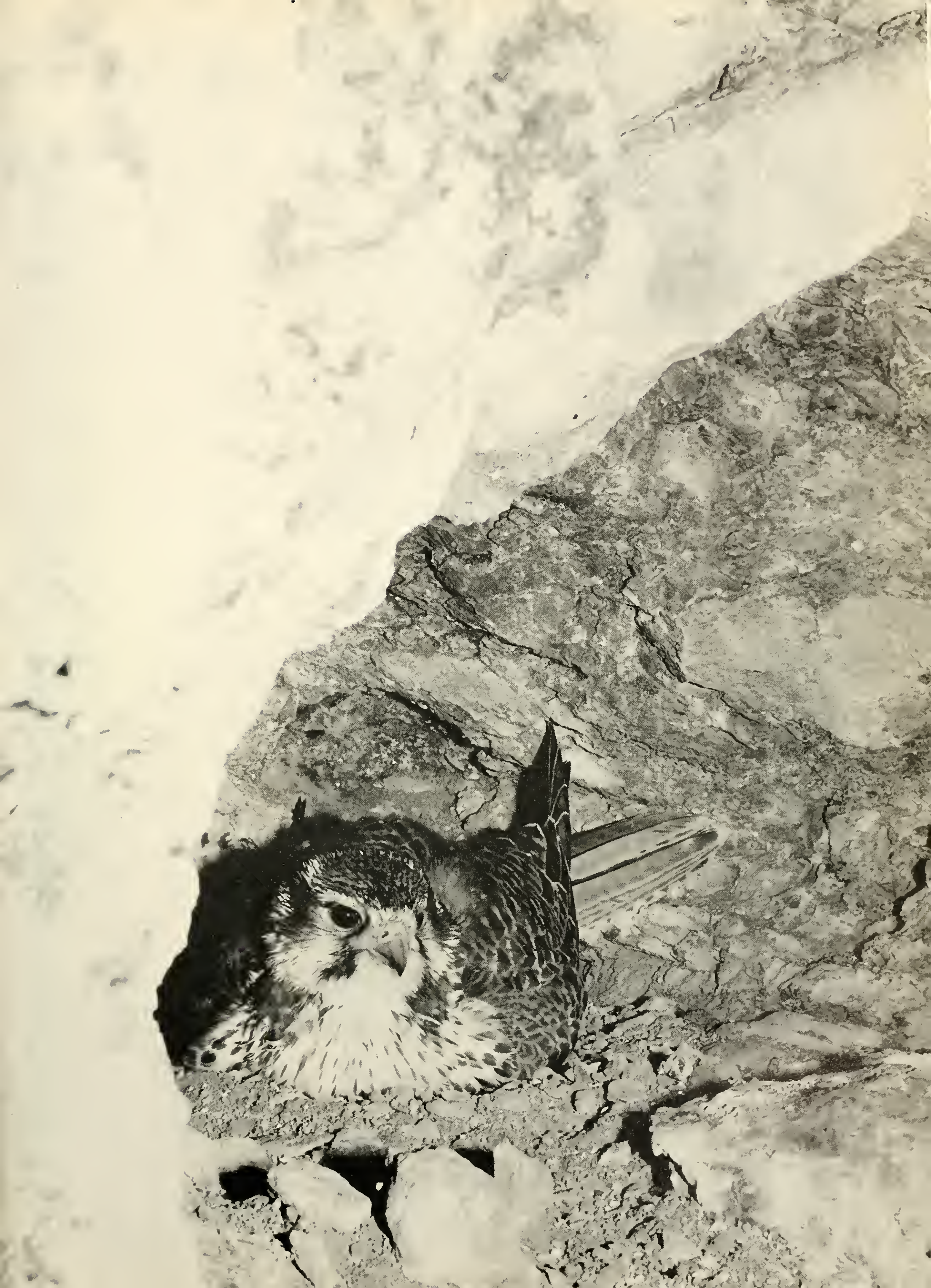
The supreme irony of nest watching is that success compounds the problem. How long will it take falconers to find the new nest, and who is going to watch when they do? More important, who is going to convince federal authorities to plug the legal loopholes that render current falconry regulations unenforceable and simply declare it illegal to possess, import, or export any race of the four rare falcons—gyrfalcon, peregrine, prairie, and pigeon hawk—found in the United States and Canada?

Falconers will object that they are not responsible for the plight of these birds of prey. This is largely true; their depleted numbers can be attributed primarily to habitat destruction, pesticides, shooting, and from earlier years, egg collecting. The point remains, however, that given the birds' precarious situation, the pressure falconers put on their reproductive cycle can no longer be tolerated.

Two boys who did a weekend watch signed out their log entry with the words "Prairie Falcons FOREVER!" Amen. But that will remain an idle hope until the prairie—along with the gyrfalcon, peregrine, and pigeon hawk—is *fully* protected. ■

In its sheltered nest on the face of a cliff, a nestling waits for its parents to return. Its diet consists primarily of ground squirrels and a few small birds.

VINCE CLAERHOUT, NATIONAL AUDUBON SOC



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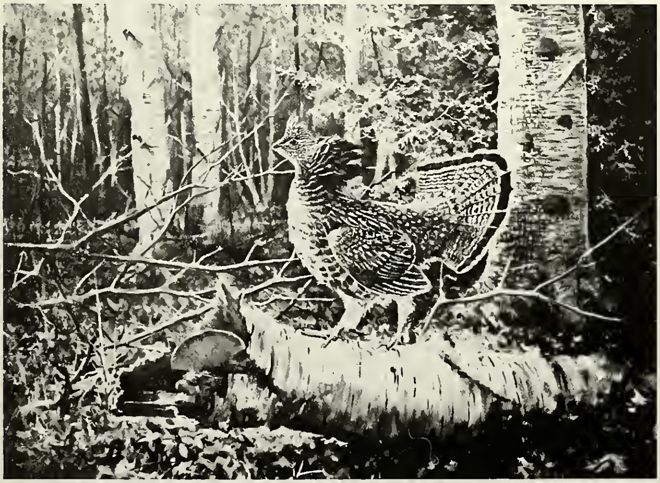
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Refugees of the Ice Age

Continued from page 35

ranges shows that there are no more than five or six species strictly limited to the system. On the contrary, the troglobites have a decided agglomeration of range overlaps in the park area. For example, Mammoth Cave is simultaneously the northern limit of one cavefish, *Typhlichthys subterraneus* and the southern limit of another, *Amblyopsis spelaea,* and it is the only known cave where the two occur together. The eyeless beetle *Pseudanophthalmus menetriesii* ranges along the narrow Pennyroyal plateau both north and southwest from Mammoth Cave, but its close relative *P. striatus* extends far out into the sinkhole plain caves southeast of the park, coexisting with *P. menetriesii* only along the inner edge of the Pennyroyal. This is all in agreement with our model, which suggests that richly diverse cave communities evolved by the gradual addition and coadaptation of immigrant species that colonized caves at different times and places.

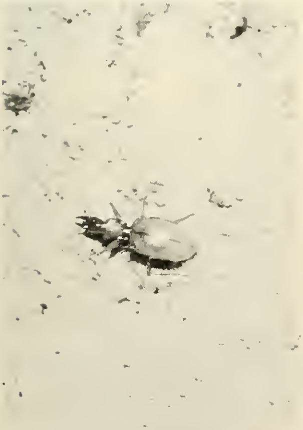
The almost limitless passage network of Mammoth Cave, with an array of heterogeneous cave microhabitats to suit the ecological requirements of many different sorts of troglobites, lies at the crossroads of two major subterranean dispersal corridors. One of these is the Pennyroyal plateau, which runs northward to the Ohio River and southwest nearly to the Tennessee border. The beetle *Neaphaenops tellkampfii* occurs along the Pennyroyal for most of this distance, and thus has one of the most extensive known ranges of any cave beetle.

The other dispersal corridor is a group of cave areas strung southeastward across the Cincinnati arch, forming a loose link between cave communities of the Pennyroyal and the western margin of the nearby Cumberland plateau. Nowhere in eastern North America do cave faunas approach the rich diversity of the central Kentucky karst except in the Cumberland plateau. This dispersal corridor, a sort of underground highway for troglobite immigrants, extends westward from the Cumberland plateau across south-central Kentucky and joins the Pennyroyal near Mammoth Cave.

In the Mammoth Cave system, then, we have found a conjunction of especially favorable conditions for the evolution of a troglobitic community composed of a rather large number of species. First, the cave is located near the margin of the eastern mixed forest community, some disjunct remnants of which persist in ravines and hollows in and near Mammoth Cave National Park. Conditions were therefore suitable for development of a diverse soil fauna whose members could contribute to the colonization of caves during the Pleistocene. Second, the cave system provides a vast amount of underground space, with a variety of microhabitats for species of differing niche requirements.

Finally, Mammoth Cave is at the intersection of two subterranean dispersal corridors, permitting movement of troglobites into the system from three directions—north, southwest, and southeast. Its troglobite community has gradually evolved by absorbing more and more underground immigrants, veritable living fossils whose immediate progenitors are extinct at the surface and whose very presence bears witness to the alternate waxing and waning of Pleistocene ice. ■

THOMAS C. BARR, JR.



The blind trechine beetle, about one-third of an inch long, feeds principally on cave cricket eggs.

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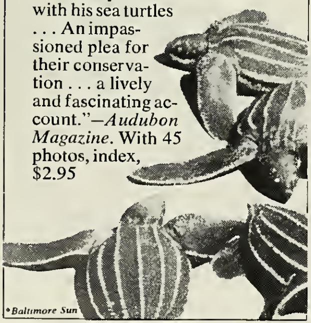

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The Lost Vikings of Greenland

Continued from page 43

rope even up to the end of the fifteenth century, long after our last written news from Greenland.

Near the churchyard where Nørlund made his find stood a Norse farm mentioned frequently in the sagas as an important trading post and the first port of call for ships that had successfully made the long journey from Scandinavia to Greenland. We can only surmise that ships continued to arrive in the fjords of Julianehaab even as late as the year 1500 and that trading continued. The population of the East settlement, decimated as it may have been, must have remained sufficiently vigorous to keep up with the latest fashion trends of eastern Europe. Over and above the struggle for survival, there must have been the continuing desire to impress their few neighbors.

In later years, Nørlund went on to excavate the site of the cathedral, which was 88½ feet long and 52½ feet wide, and the bishop's domicile at Gardar, which was 164 feet long and contained a banquet hall large enough to serve several hundred guests. The site also included numerous smaller buildings for the storage of tithes and taxes, in the form of wool, furs, and walrus teeth, as well as barns that housed as many as 100 cows. The farm of Eric the Red at Brattahlid was excavated by Nørlund in 1932. Like the other buildings of Viking settlements, Eric's farmstead was designed to meet the practical needs of climate and occupation.

Subsequent excavations made by the Danish National Museum at the East settlement as well as at the site of the West settlement to the north, established a special style of Greenland construction. Farmsteads consisted of fifteen to twenty rooms with humans and their cows, horses, sheep, and pigs living together under one roof. Building materials were turf, which is exceptionally compact in northern latitudes, and stone boulders set into the ground to lend stability and support. Low, turf-covered roofs spanned the rooms, sloping gradually to three- to four-foot-thick turf walls calculated to keep the quar-

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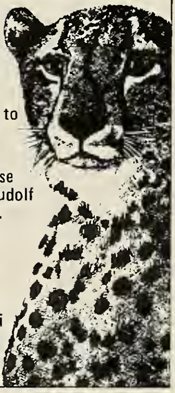

ters warm. Dwellings had long fireplaces and often included pantries and bathhouses. These farms, shaped by wind and weather like the landscape itself, must have looked from a distance like insignificant hummocks under the towering mountains, with only an occasional wisp of smoke rising above the rooftops to suggest the human habitation within. On the inside, these houses must have been as cosy, snug, and busy as a hive. Even in wintertime, on at least one occasion following a wedding, the sagas tell us that at Eric the Red's farm "there was much chess playing, and story telling, and many other entertainments that enrich a household." And there were "great discussions" about going in search of Vinland "where, it was said, there was excellent land to be had."

Then in the fall of 1961, a visitor from Greenland brought to my office at the National Museum in Copenhagen a round parcel wrapped in pink tissue paper and announced that it contained the skull of Eric the Red. Workmen digging the foundation of a hostel for school children from outlying sheep farms had unearthed the skull at a village on the site where Brattahlid had once stood. It had first been thought to be the skull of a sheep, but examination proved it was human and Norse; could it be that of Eric the Red?

The possibility that I held Eric the Red's skull in my hand, and that other archeological treasures might also lie buried where it had been found, was enough to send me quickly to the site of Brattahlid for a firsthand look. When I got there and peered into the hostel foundations dug by the local workmen, I could see the dark contours of several graves. In the low sunlight, shadows also revealed the faint traces of the walls of a small building. The larger ruins of Eric's farm had already been uncovered a mere 300 yards away on lower ground. This newly uncovered small building, I thought, was most likely Thjodhild's church—the first church built in the New World. Extensive excavations undertaken in the following summers by Knud Krogh, an architect, confirmed its identity. Probably dating back to the end of the year 1000, the church was of modest proportions: 11½ feet long

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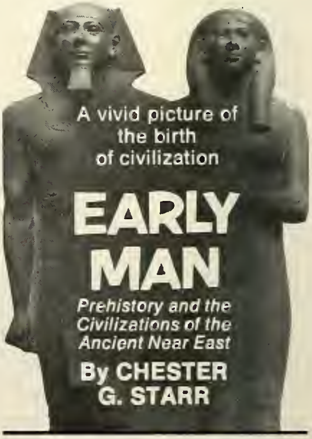

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and 6½ feet wide. Not more than twenty worshipers pressed closely together could have stood at one time under its roof. Like other buildings of the Viking settlements, this church had a thick turf roof and walls; it also had one wooden gable facing west.

Surrounding the church was a graveyard from which the skeletons of 144 men, women, and children were excavated. These remains came from the earliest generations of Greenland Norse, for sometime during the eleventh century, a larger stone church with its own graveyard had been built directly in front of the Brattahlid farmhouses, and Thjodhild's church fell into disuse. Judging by the skeletons' measurements, which match those of contemporary Scandinavians, these Vikings had powerful musculature and were a tall, strong people. We do not, however, know their individual identities. In the early days of Christianity in Greenland, the church banned the pagan custom of burying grave goods with the dead, but gravestones had not yet come into use. The skeletons therefore remain anonymous.

Eric the Red's Saga ends with the story of the long voyage to Vinland by Thorfinn Karlsefni, an Icelander who had married the widow of one of Eric's sons. For three years Thorfinn led a party of 160 in exploring the new land discovered a few years before by Leif the Lucky. Many of the men took their wives and all kinds of livestock with them, "for it was their intention to colonize the country, if they could do so." Thorfinn's wife, who accompanied him, bore him a son in Vinland. During their explorations, some of the would-be colonists were killed in encounters with Indians. Perhaps fearing more attacks, the survivors abandoned the project and returned to Greenland.

We do not know where all these early American explorers were buried but some of them ended up in the anonymous graves next to Thjodhild's church. And even if the skull that came to the Danish National Museum wrapped in pink tissue paper is not that of Eric the Red, it could well be that of one of the first Europeans to tread the North American Continent about five hundred years before Columbus made his historic landfall. ■

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The photographs were taken by Ralph L. Shook on a bitter cold day in February, with the wind at 15 miles per hour. He spent many hours waiting for his eagle to visit this favorite perch. The picture at the right shows the whole scene with his Kodak Instamatic — his Field Model Questar set up in a blind, 150 feet from the bird's tree. His modified Nikon with through-the-lens meter is close-coupled to the telescope and the arrow points to the empty branch. Above, the Questar photograph is cropped from an 8 x 10 enlargement of 35 mm. Tri-X, taken at f/16, 1/250 second.

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Celestial Events

by Thomas D. Nicholson

The Sun and Moon Although the sun continues to move up the sky as its apparent motion along the ecliptic takes it eastward, its northerly drift slows in late May and early June as it approaches the summer solstice. This, in turn, has its effect on the changing length of the day and the times of sunrise and sunset. At latitude 40° north, sunrise occurs at 4:45 A.M., local mean time on May 15, and only 15 minutes earlier on June 15; sunset on May 15 is at 7:08 P.M.; 22 minutes later on June 15. The changes are only about half a minute per day. The duration of daylight continues to increase until later in June.

With full moon in May on the 16th, bright moonlight will fill the sky all night in mid-month. As the moon wanes, it rises after sunset, progressively later each night, but continues to fill the sky with moonlight until dawn. It wanes to last-quarter on May 25 and, after a few days as a crescent in the morning sky, to new moon on the 31st. By June 3, the waxing crescent should be seen in the evening sky, growing nightly until it reaches first-quarter on June 7 and full moon on June 15.

Stars and Planets Although summer hasn't arrived yet, summer stars are in the early evening sky. By the times for which the Star Map was prepared, the three bright stars of the Great Summer Triangle are up in the east: Vega well above the horizon; Deneb lower, toward the northeast; and Altair just rising below Vega. And in the southeast and south, it is easier to find Scorpius, Sagittarius, and Capricornus now than it will be in August and September, although these are summer constellations. Instead of only the one planet, Saturn, that we have had for much of the winter and spring, we now have three—Saturn, Venus, and Mercury. But all three are very close to the sun, setting so early in the twilight that it will be difficult to see them.

Jupiter and Mars are still prominent morning stars; Jupiter rising before midnight, Mars about three to four hours before the sun.

May 19: The moon is farthest from earth, at apogee.

May 20: Mercury is at superior conjunction, passing the sun from right to left in our sky. The planet now becomes an evening star.

May 23-24: The planet rising near the moon late on the 23rd is Jupiter. It moves up into the south—below and to the left of the moon—in the dawn sky of the 24th.

May 24-25: The moon rises between Jupiter and Mars late on the evening of both dates. Jupiter (to its right) is closer on the 24th, Mars (to its left) is closer on the 25th.

May 30: Venus, entering the evening sky, and Saturn, leaving it, are in conjunction, but both set very early in the evening twilight.

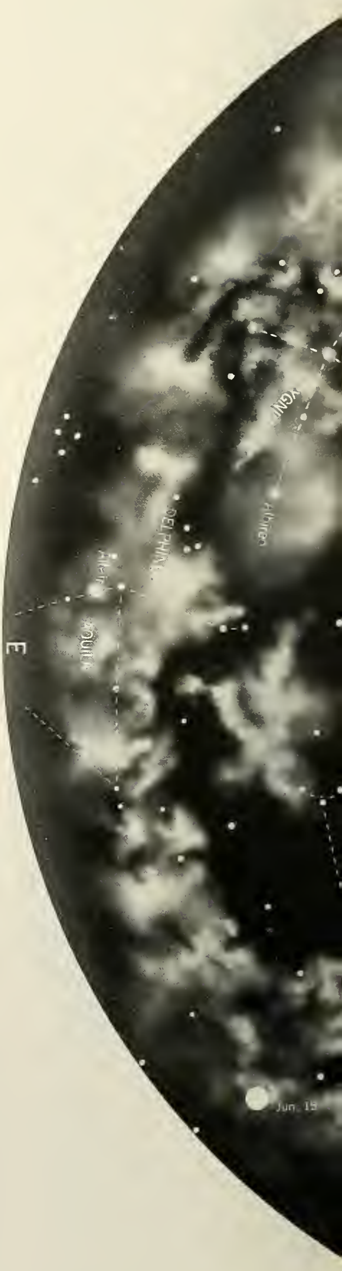
May 31: Jupiter becomes stationary in right ascension, a sign that it is soon to enter the evening sky.

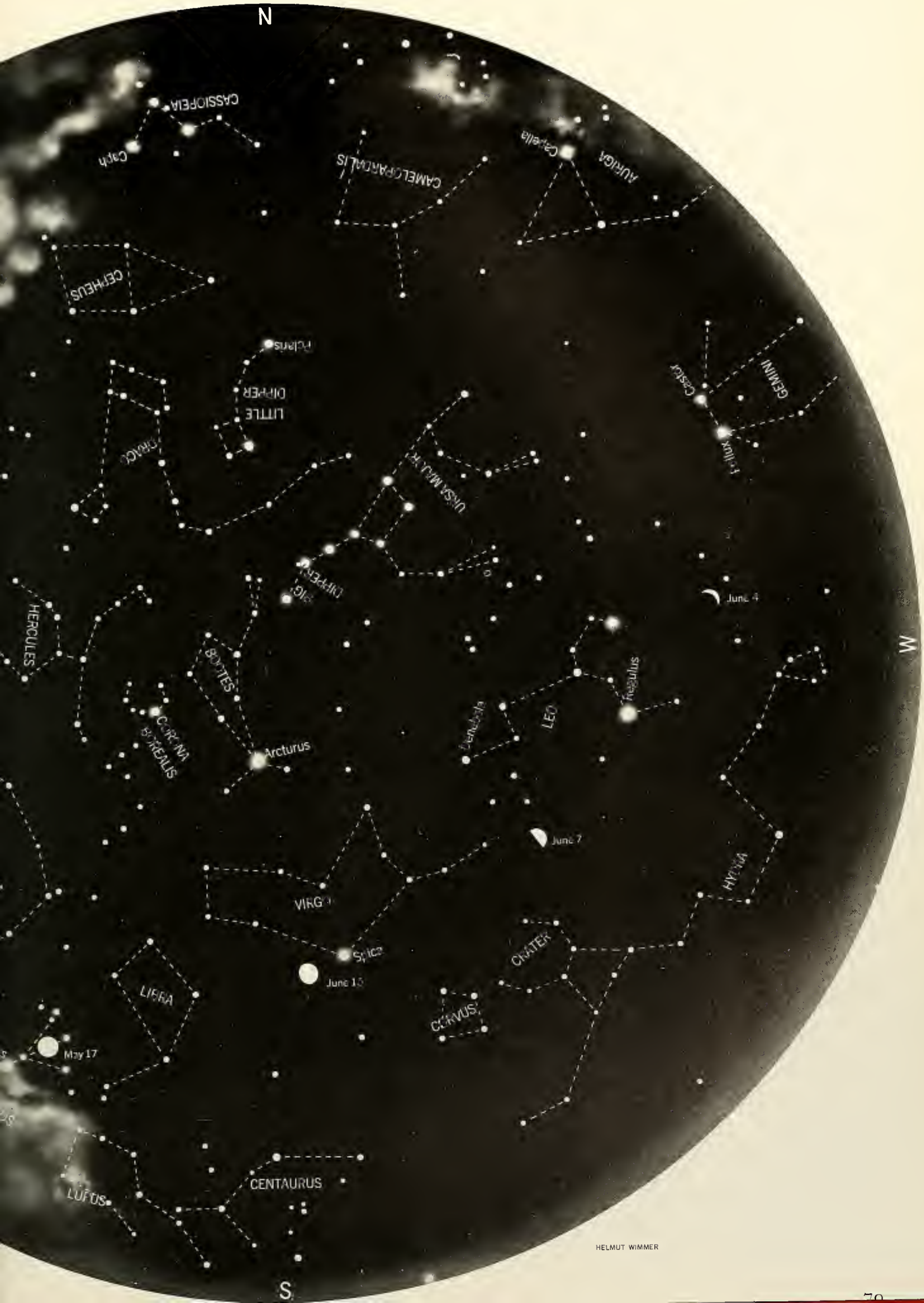
June 1: Perigee moon today (nearest earth), and it was new yesterday. Watch for exceptionally high perigee spring tides.

June 2: Mercury is in conjunction with the moon and occulted by it over parts of the Southern Hemisphere.

June 15: The moon is at apogee and becomes full three and a half hours later. The resulting apogee spring tides are interesting but nothing to worry about: lower highs, higher lows. There is also a penumbral eclipse of the moon (sunlight is partially blocked from the moon by the earth), producing only an imperceptible darkening of the full moon.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:25 P.M. on May 15; 9:20 P.M. on May 31; and 8:20 P.M. on June 15; but it can be used for about an hour before and after these times.




N
CASSIOPEIA
Caph
CAMELOPARDALIS
Capella
AURIGA
CEPHEUS
Polaris
LITTLE DIPPER
DRACO
URSA MAJOR
GEMINI
Castor
Pollux
BIG DIPPER
June 4
HERCULES
BOÖTES
CORONA BOREALIS
Arcturus
Denebola
LEO
Regulus
W
June 7
HYDRA
VIRGO
Spica
June 13
CRATER
LIBRA
CORVUS
May 17
LUPUS
CENTAURUS
S

HELMUT WIMMER

by Richard M. Klein

The Greening of Indoor America

or Why People Turn to Plastic Plants

Reading some of the current crop of books on indoor and city gardening gave me that old feeling of *déjà vu*, rising from root to stem tip. One sees the same pair of clean(!) disembodied hands troweling dirt into the same clay pot. About the only unexploited switch would be to have a *Playboy* "how-to" garden book and have a Bunny attached to the hands.

Let's be specific. Charles Scribner's Sons publishes the "Scribner Garden Library"—hard-cover books with cocktail table dimensions, excellent photographs, and unusually fine line drawings. Most of the series is being written by Jack Kramer. *Your City Garden* (1972; $6.95) apparently was written for the San Francisco Bay area where even a meat ax can't kill a plant. Layouts are provided for decorator chic pocket gardens, but it would cost a fortune to build and maintain these gardens and some designs wouldn't meet many city building codes. The lists of plants for such gardens do not take hardiness zones into account, and more comprehensive lists can be found in many seed and nursery catalogues, which also provide more data on hardiness, resistance, and growing conditions. A line like "compost piles are difficult to have in the city . . ." will hardly enlighten the reader.

Kramer's *Miniature Plants Indoors and Out* (1971; $5.95) discusses the cultivation of miniature roses, geraniums, gesneriads and other plants in terraria, dish gardens, and the like. A section of the book devoted to Bonsai is misleading. Again, lists of useful plants are incomplete, but the author does provide names and addresses of suppliers. A third Kramer book, *Grow Your Own Plants* (1973; $6.95) superficially discusses sexual and asexual reproduction and the general cultivation of houseplants and some outdoor species. The rank beginner won't be able to hack it with the information supplied and anyone who has grown more than a coleus for six months doesn't need this volume.

Virtually everything that Kramer discusses in his books can be found—and in more detail—in the no-nonsense Handbooks of the Brooklyn Botanic Garden, 1000 Washington Avenue, Brooklyn, N.Y. 11225, each selling for less than $2.00. Handbook illustrations are clear and although the text isn't deathless prose, the articles are precise. A selection of these Handbooks will provide the neophyte or even the near professional with all the information needed to grow just about everything. A postal card will get you the list of available Handbooks. Order freely and with confidence. As an example, the two Handbooks on Bonsai are exceeded in detail only by the classic English language book by Yashimura and Halford (*Japanese Art of Miniature Trees and Landscapes*, Charles E. Tuttle Co.), and the beginner isn't ready for Yashimura anyway.

As in the case of cookbooks, which are also usually repetitious, one occasionally comes across a "how-to" book on plants that is interesting because it is so specialized. Hazel Perper's *The Avocado Pit Grower's Indoor How-To Book* (Walker and Co., $2.95) has gone through eleven printings since it was first published in 1965. Bound in (naturally) avocado green, it covers no more and no less than the title says. With this book and an avocado pit, you *can* grow an avocado tree. I want to give this book a rave review if only because I have been bedeviled for years by people who come to me with a questioning look and a slimy pit clutched firmly in hot hand. But I can't understand why anyone would bother; grapefruit seeds are cheaper to obtain and a dime store philodendron is handsomer.

With everything but a ruffle on a snare drum, Quadrangle Books has just announced the publication of *The New York Times Book of*

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NATURE AND THE AMERICAN: Three Centuries of Changing Attitudes
By Hans Huth

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House Plants by the *Times'* garden editor, Joan Lee Faust (1973; $9.95). What a swindle this one is! It has four columns (a column is here defined as a full-page length of print which is ⅔ of a page wide) on fertilizers, five columns on potting and pruning, and three columns each on lighting and watering. The center of the book consists of a number of pages, each containing great blank spaces with small, smudgy, colored drawings of houseplants and a few almost inconsequential remarks on each plant. My 1973 seed catalogues contain more information and have better pictures. Ms. Faust's editorial gimmick, her "Calendar of Care," devotes one column to each month with an average of seven profound tidbits per column. For March we are told, "Plant seed of the new hybrid geraniums or take cuttings of the scented geraniums." May informs us to "turn pots of Gloxinias every few days to keep leaves wide and flat." We are exhorted to "stock up on house plant supplies, especially pots, fertilizers, and soil ingredients" for September. For $2.50 one can get *House Plants* (#40) and *A House Plant Primer* (#70) from the Brooklyn Botanic Garden series, set your pots on a copy of the Sunday *Times* ($0.50) and still save $6.95.

Alan E. Simmons' book, *Growing Unusual Fruit* (Walker and Co., 1972; $10.00), is worth reading. Mr. Simmons, apparently writing for a British audience, has gathered together horticultural information for growing many plants, mostly woody, that one would not have thought were growable under house or small garden conditions. How successful the city gardener would be with custard apple, guava, carambola, marmelos, or zabala is an open and intriguing question. The instructions are sufficiently vague, suggesting that the grower be fairly experienced, and sources of seeds and plants are not given. This latter problem is minimized these days what with supermarkets stocking kiwi fruit, mango, and prickly pear, all of which are covered in this book. One might be able to grow a conversation piece if nothing else and, besides, none of the Brooklyn Botanic Garden Handbooks supply this information.

Just as it might be useful to declare a moratorium on articles expanding on the parlous state of the overfed and oversexed American suburb, so it might also be well to stop publishing nonbooks on houseplant gardening. This is especially true of the current crop, which does not provide the beginning home grower with enough solid, detailed, and accurate information to justify inflated prices. I don't own stock in any plastics company and I do have a vested interest in live plants, but after reading the books reviewed here, I can see why many people have turned to chemical foliage for their living rooms and patios. Growing plants in the city isn't easy, and the gardener's green thumb is a reality. But the green thumb is neither a gift from on high nor the product of a fortuitous genetic recombination. Common sense and accurate, complete information will allow anyone to be a howling success in city horticulture.

A "how-to" for buying books on any aspect of gardening would include the following tips. Never pay more than $6.00 for a volume; money saved by using a soft cover could be put into text and illustrations. Don't pay for clever layouts; wall-to-wall text is what supplies facts in abundance. Downgrade books with color photographs; they are expensive, distracting, and usually unnecessary. Look for detailed lists on species or varieties, names and addresses of suppliers, geographical hardiness zones, and sun versus shade requirements. Plants need light, water, fertilizers, cultivation, and appropriate temperatures and humidities. Many require special conditions to permit growth and development and unless the book specifically answers all these questions for the plant of interest, and in detail, don't buy it.

Dr. Richard M. Klein is professor of botany at the University of Vermont in Burlington.

THE TIME OF THE BUFFALO, by Tom McHugh. *Alfred A. Knopf, $10.00; 384 pp., illus.*

This is an objective study of the species *Bison bison*, rather than a polemic on the near extinction of the American buffalo. According to Cortés, whom the author quotes, the buffalo was a beast

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I remember watching the end of a televised movie a year or so ago in which mighty hunters in pick-up trucks were using high-powered rifles to dutifully "reduce" a herd of park buffalo from a distance of about 200 yards, while children, watching from nearby, wept as the buffalo sank to their knees and keeled over. The camera swept from one set of faces to the other, from "evil" to "good," and the soundtrack, playing "Bless the Beasts and Children," was about as subtle as the photography. If one of those hunters had ever faced a buffalo bull straight on at fifteen paces or if one of the children had been charged by an enraged cow, sentimentality and its concomitant, brutality, might have suffered a mortal blow. A lone buffalo has been known to kill an attacking grizzly bear.

The Plains Indians, on the other hand, revered the buffalo but were not sentimental about it. They were, themselves, as organically related to the buffalo as wolves were—natural links in a chain in which, to paraphrase the author, energy flowed from soil to plant to animal to predator and back again. The bison were, in the words of another early explorer McHugh quotes, "the food of the Natives, which drink the bloud hot, and eate the fat, and often ravine the flesh raw. [They were] meat, drink, shoes, houses, fire, vessels and their Masters whole substance." When the thirty million buffalo that existed in 1830 had been "reduced" to little more than a thousand by 1889, the Indians had also been killed or confined to reservations.

The logic of this enormous slaughter was summed up in a speech Gen. Phil Sheridan made to the Texas legislature, which was considering a bill to save at least some of the remaining herds in that

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state. Sheridan praised the professional hide men who had killed three million buffalo during 1872, 1873, and 1874 alone:

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The Time of the Buffalo is a humane, scholarly work that encompasses the history of the species from the Ice Age to the present. Because of its unemotional presentation, it is likely to become the definitive study of an animal that now numbers about thirty thousand. That the buffalo has made a limited comeback in parks and refuges can be attributed to unsentimental naturalists, like Tom McHugh, who are engaged in "a fierce struggle against our culture's reckless disregard for rare wildlife, primitive peoples, and irreplaceable timberlands, marshes, seashores, and other natural domains."

H.L. Van Brunt

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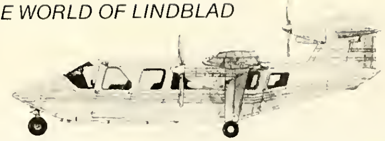
Erratum: Due to a typographical error in Jean Briggs's review of *Pitseolak* (March, 1973), the Eskimo word for shaman was misspelled. The correct word is *angaqquq*.



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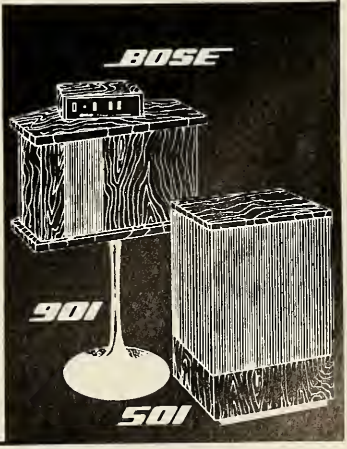

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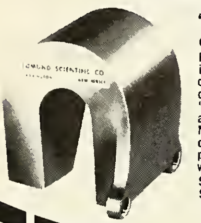

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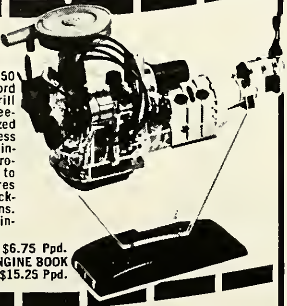

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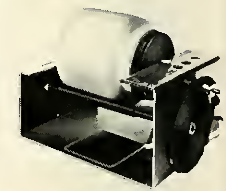

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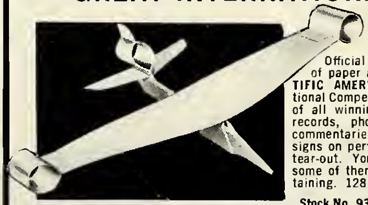

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The View from the Road. D. Appleyard et al. The MIT Press, Cambridge, 1964.

The Image of the City. K. Lynch. The MIT Press, Cambridge, 1960.

Making the City Observable. R.S. Wurman. The MIT Press, Cambridge, 1971.

REFUGEES OF THE ICE AGE

Biospeleology. A. Vandel. Pergamon Publishing Company, Elmsford, 1965.

The Life of the Cave. C.E. Mohr and T.L. Poulson. McGraw-Hill Book Company, New York, 1966.

The Caves Beyond. J. Lawrence, Jr. and R.W. Brucker. Funk & Wagnalls, Inc., New York, 1955.

THE LOST VIKINGS OF GREENLAND

A History of the Vikings. G. Jones. Oxford University Press, Inc., New York, 1968.

The Vinland Sagas. M. Magnusson and H. Palsson. Penguin Books Inc., Baltimore, 1965.

The Norse Atlantic Saga. G. Jones. Oxford University Press, Inc., New York, 1964.

THE SQUALOR THAT WAS ROME

Life and Leisure in Ancient Rome. J.P. Balsdon. McGraw-Hill Book Company, New York, 1969.

Roman Society from Nero to Marcus Aurelius. S. Dill. Gordon Press, New York, n.d.

Lives of the Caesars. Suetonius. Loeb Classical Library Nos. 31, 38, Harvard University Press, Cambridge.

THE BISON IS BELEAGUERED AGAIN

The North American Buffalo. F.G. Roe. University of Toronto Press, Toronto, 1970.

The World of the Bison. E. Park. J.B. Lippincott Company, Philadelphia, 1969.

Veterinary Pathology. H.A. Smith et al. Lea & Febiger, Philadelphia, 1972.

FOLK ART IN THE BARRIOS

Chicano Manifesto. A.B. Rendon. The Macmillan Company, New York, 1971.

People's Art. R. Sommer. *Natural History*, February, 1971.

Mexican Painting in Our Time. B.S. Meyers. Oxford University Press, Inc., New York, 1956.

FOILING THE FALCONERS

The Falconer's Paradox. G. Laycock. *Audubon*, September, 1971.

Eagles, Hawks, and Falcons of the World. L. Brown and D. Amadon. McGraw-Hill Book Company, New York, 1968.

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A DOUBLEDAY ANCHOR NATURAL HISTORY BOOK

At Random

by Alan Ternes

When clouds and tempests roll across France and become ensnarled in the Alps, most of Switzerland is covered with a thick, oppressive gray blanket. But even at such times the remote southeastern corner of the country often remains bathed in bright Mediterranean sunlight. When heavy clouds lined the northern horizon, I have stood atop the rounded, sun-soaked peak of 7,500 foot Mount la Schera surrounded by radiance. Bright red lichen stood out sharply against the yellowish peaks, which in turn were etched against the deep blue sky. And below, to the south, verdant forests ringed the deep valley lakes of northern Italy.

Under such sunlight, the landscape—with its strong highlights and dark shadows—seems dreamlike, especially from the smog-smothered perspective of a New York City officegoer. In this light it is easy to understand the dream and vision of the men who founded the unique Swiss National Park. Yet one cannot ignore the shadows or the realization that the dream is dead.

Not that the Swiss National Park is dead. If you take the Pass dal Fourn from northern Italy to Zernez in southeastern Switzerland, you drive through the center of the 60-square-mile park. It is in the most traditional, least-developed section of the country, where Romansh—an ancient language closely related to Latin—is still spoken. And the park is the least developed of all. It has no improvements: no cable cars inching up to its rocky peaks, no ski tows, no mountaintop restaurants. There are only a few foot trails winding through the silent valleys and over the sharp ridges. It is possibly the only place in western Europe where you can look across a range of valleys and mountains without seeing a trace of civilization. Many visitors are bored in half a day; others, including myself, are reluctantly pulled away after a week by telegrams and dimly remembered work obligations.

But a great park is more than land; it is also an idea and, in this case, an ideal. In 1906, when the concepts of modern ecology were still mainly unknown, the Swiss Academy of Sciences started a search for a natural area that would be allowed to evolve without human interference. Protected by federal decree, a large part of the present park was founded in 1914.

It is difficult for us in this ecologically aware time and land-abundant continent to appreciate the foresight of the Swiss naturalists and biologists. They saw the need to create a unique laboratory, one that would evolve by the laws of nature. They asked: What is the true vegetation of the Alps? What are the natural populations of deer? the agile chamois? the marmot? Is an alpine meadow natural or something created by cattle? These and thousands of other ecological questions could only be answered by letting a large area evolve for centuries without human interference.

So the Swiss, with dedication and thoroughness, set aside a relatively large part of their country for natural science. They excluded all kinds of human disturbance: there would be no timbering, no grazing by cattle, no hunting or fishing, no rock climbing, skiing, fires, or camping. The major exception was a small number of footpaths. Visitors could hike on these trails, but they could not step off them. These regulations have been enforced for sixty years and are observed by most visitors. You can find, next to the most-frequented paths, the delicate edelweiss in bloom. A recent visitor was fined for killing a viper.

It would seem, then, that this idealistic plan to establish a true natural area in Europe has worked. Many natural scientists have been drawn there, especially for the study of plant and animal populations. Dr. J. Braun-Blanquet did part of the field work in the park for one of the first plant ecology books, *Plant Sociology*, published in 1932. Others have studied the populations of ungulates: the ibex, the chamois, the roe, and the red deer. With hunting banned, these animals increased, and the first three species have reached a natural balance of population with the alpine environment.

The red deer is the exception. It had been hunted out of the region by the time the park was created, but a small herd soon moved there by natural dispersion from nearby Austria. In 1918, only 9 deer were recorded, but by 1930, there were 135, a total of 660 by 1950, some 850 by 1960, and 1,500 by 1970. In fifty years the red deer became the dominant animal of the lower slopes. They gathered in herds and grazed so heavily that large areas were denuded of vegetation and opened to erosion. They also crossed the boundaries of the park and ate crops on surrounding farms.

It is easy, with hindsight, to spot a tragic flaw in the original proposal for the park. What the founders had overlooked was the need for a large predator. The park is not big enough for the brown bear, which still can be found in one wild part of northern Italy. And the maligned wolf, the natural creature for limiting and dispersing the deer population, was already extinct in the region in the last century.

Pressured by angry farmers and by the sight of overgrazed parts of the park being eroded away, the director tried to solve the dilemma with a compromise. In September, 1971, he joined with several wardens to drive most of the red deer out of the park, hoping to break up the concentration of herds in overgrazed areas and to disperse them into wooded nonpark areas along the Italo-Swiss frontier. Within a few days almost every deer was back in the park.

Last fall, they again drove the deer out of the park, but this time other wardens and hunters were waiting and a large part of the herd was shot down. Since they slaughtered the deer outside the park, a token of the park's sanctity remained. But the greater dream—the creation of a beautiful, *natural* alpine setting without man's impact—died with the echo of gunfire in the valleys of those Swiss mountains. ■

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NATURAL HISTORY

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NATURAL HISTORY

Top Shops Shun Simmons

Bet you can't say it three times, fast.

Actually, we're not much concerned about saying it. What's important to us is that more and more big agencies are doing it!

For three months we've been telling the world that Simmons' sampling and interviewing techniques simply can not accurately measure the audiences of selective magazines like ours.

Our message is getting through. So far, more than a dozen major agencies have decided to discard Simmons data for Natural History, Intellectual Digest and Smithsonian.

What seems, more than anything else, to have provoked agency questioning of Simmons figures for Natural History is the vast difference between Simmons demographics and those emerging from our own subscriber studies.

Natural History has conducted a long series of such studies -- and they tell a story of consistent quality. When you compare highlights from the last two against the current Simmons, it looks like Simmons has given us someone else's numbers by mistake!

	Subscriber Studies		Simmons
	1969	1971	1973
Education			
Attended College	83%	84%	64%
Graduated College	67%	66%	48%
Occupation of HH Head			
Managerial	27%	26%	12%
Professional, Technical	41%	41%	33%
Household Income			
$15,000 and Over	61%	62%	47%
$25,000 and Over	28%	29%	11%

Naturally, a magazine expects some dilution of audience quality when you go from primary to total audience -- since pass-along readers generally have lower demographics than subscribers.

But Simmons actually credits us with fewer readers per copy than our most recent subscriber study!

It seems to us you can't have it both ways. If our total readership is truly no larger than our primary audience, then our total demographics should resemble subscriber figures. If total audience demos are lower, there ought to be more pass-along to explain why.

It's good to see the agencies coming around to our point of view. We hope it means the big Simmons fuss is about over. After all, when you have the kind of upscale selling story Natural History has, you want to spend all your time telling it...not defending yourself against research that has obvious difficulties trying to measure selective audiences like ours.

Let's get back to business.

Cordially,

Harvey Oshinsky

Harvey Oshinsky
Advertising Director

NATURAL HISTORY

Incorporating Nature Magazine
Vol. LXXXII, No. 6
June-July 1973

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Cover: *The costume of an islander participating in a traditional dance ceremony reflects the Americanization of life on Yap, in the Caroline Islands. Photograph by Dorreen Labby. Story on page 26.*

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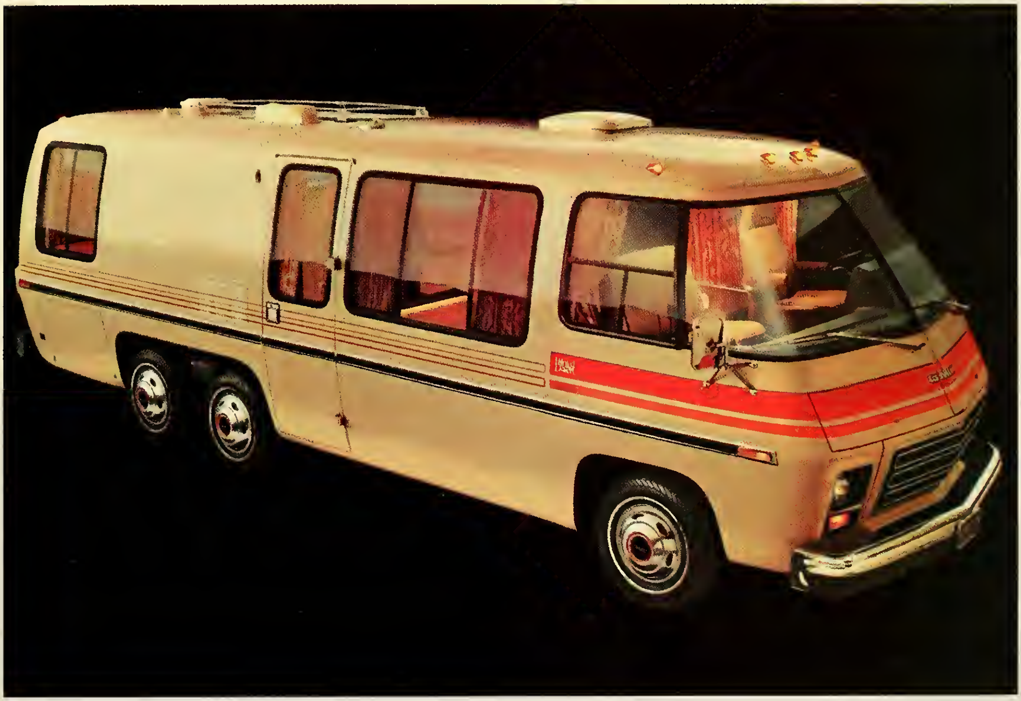

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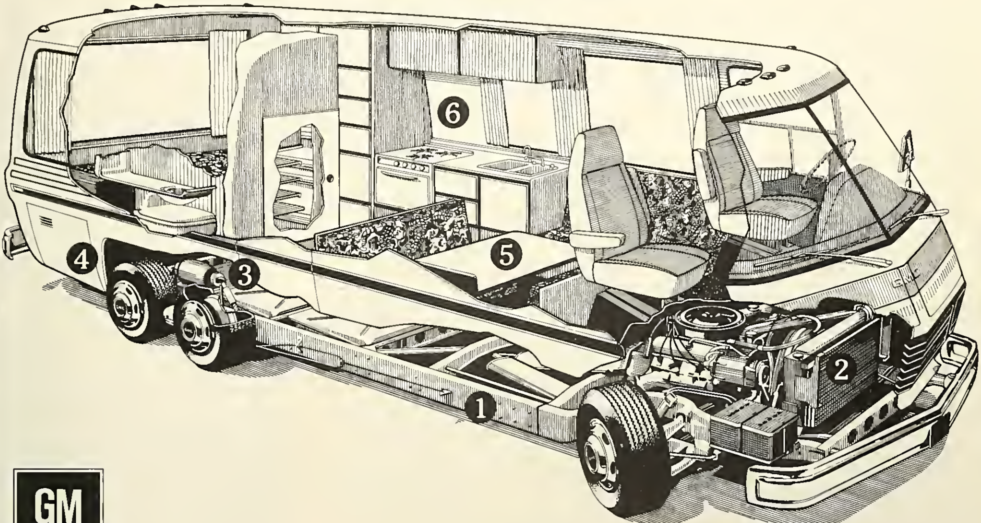

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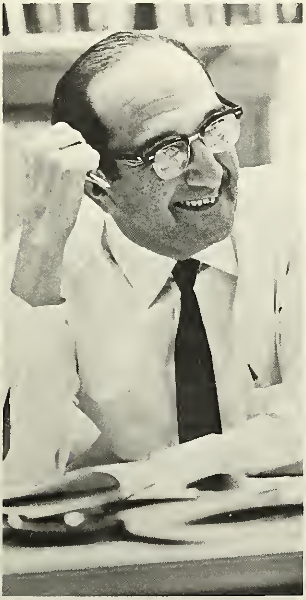


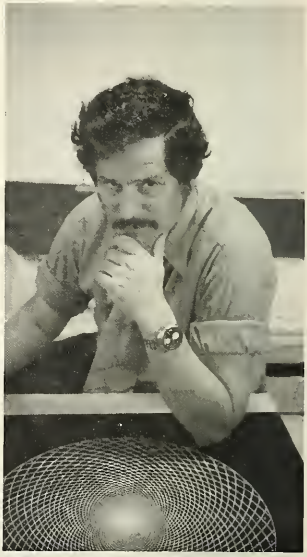
Salvador E. Luria

A belief that scientists have a responsibility to inform the public led **Salvador E. Luria** to write a comprehensive review of molecular biology for the layman. "Genesis" is excerpted from this work, which will be published shortly by Scribner's under the title *Life—The Unfinished Experiment.* Luria is Institute Professor of Biology at the Massachusetts Institute of Technology and director of its Center for Cancer Research. He shared the 1969 Nobel Prize in physiology with two other American scientists "for . . . discoveries concerning the replication mechanism and the genetic structure of viruses."

David Labby

For two years **David Labby** lived on the island of Yap in Micronesia, documenting traditional living patterns and the abrupt social changes brought about since American administration began in 1945. Presently a researcher for the University of Chicago's Department of Anthropology, Labby's future plans call for a study of working class culture in America. **Dorreen Labby**, who accompanied her husband to Yap, is a freelance photographer and newspaper reporter.

Dorreen Labby



Willard K. Martin

An architect interested in forms and systems, **Willard K. Martin** has been studying and sketching seed pods on his travels and during his spare time for twelve years. In the parts of a seed system and their bearing on function, he finds lessons for contemporary art, architecture, and engineering. Martin studied at the Palais de Beaux Arts at Fontainebleau, France, and earned a Bachelor of Architecture degree from the University of Oregon in 1957. He is currently a principal in a Portland, Oregon, architecture firm. Time permitting, Martin intends to continue his study of seed pods and also to look into plant megastructure systems for future urban concepts.

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Garrett C. Clough

After studying the behavior and ecology of lemmings in Norway, **Garrett C. Clough** turned his attention to a much more obscure rodent, the Bahamian hutia. The data gathered on his four field trips to East Plana Cay—the only site in the world where this particular species survives—have contributed much of what is presently known about this nocturnal animal. Clough is a professor of human ecology at the University of Rhode Island. He is interested in the humanistic aspects of science and is attempting to construct a new ethic based on ecology. He also plans to return to Norway to continue his work with lemmings.

Charles Vaurie

Charles Vaurie has devoted most of his career to studying the distribution and systematics of Palearctic birds, and his two-volume work, *The Birds of the Palearctic Fauna,* is considered a classic in its field. He is also interested in South American birds and for the past four years has been preparing a monograph on ovenbirds. Vaurie, who was recently appointed curator emeritus in the Department of Ornithology at The American Museum of Natural History, also works six months a year at the Muséum National d'Histoire Naturelle in Paris.

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Letters

A New Conservation Concept

The excellent article on "The Black Rhinoceros" by John Goddard [April, 1973] has inspired a new concept in their conservation. Suppose that an endangered animal were shot with a tranquilizing gun and its horn sawed off and a few pints of blood removed. The horn could then be replaced by a precast fiber glass substitute and the animal revived. The animal would then be unsuitable for trophy sport or for poaching and would probably survive unless it encroached on some farmer's land. Furthermore, the authentic blood and horn could be sold in the Orient, financing efforts to preserve the species.

Stuart L. Bench
San Francisco, California

Smokey and the Law

The point of Dr. Cowles's article [April, 1973] is well taken; however, in practical terms it will take more than a change in attitude to practice preventive burning. Government agencies have set up a legal framework in which they sustain no liability for damages. If a government bureau sets a fire and if the fire gets out of control and results in destruction of property or loss of life, then the aggrieved persons would present such outrage that all officials connected with the act would be fired. Complete suppression of fire means that any fire, no matter how destructive, can be attributed to criminals or an act of nature, and the agency and its employees are absolved of all legal responsibility. Purposeful burning will not be carried out on any regular basis until a satisfactory system is devised, providing for adequate compensation and mollification of the aggrieved individuals when unintentional losses occur.

W. E. Sharp
Columbia, South Carolina

Win Some. . . .

I liked Jecon Gregory's wonderful "Metamorphoses of the Monarch" [April, 1973] very much. It has that perfect equilibrium of delicacy and strength that is always the mark of the genuine. An extraordinary feat from, clearly, an extraordinary person.

James Zito
Bronxville, New York

And Lose Some

Excellent story on Jumbo [February, 1973], but Zoological Gardens in London have never been Royal to my knowledge as a longtime fellow. I think they wish they were so honored.

Henry Field
Miami, Florida

The Ultimate Threat

Perhaps I can be permitted a belated comment on "The Riddle of the Pig," by Marvin Harris, which appeared a few months ago.

A group I was with one evening was involved in a wide-ranging discussion of the same problem. After a few drinks, I proposed a minor-league anthropological speculation, which I share with you.

My solution is that the dietary restriction may reflect a cannibalistic era in the dim past. The taste (I am told) of pork and human meat is similar, to the point where man, considered as food, has often been referred to as Long Pig.

If this premise is accepted, the rest of the scenario becomes almost self-evident. In order to move human society away from this practice, it is natural that taboos would be instituted—even *human-tasting* foods would be verboten. There are many clues around us. Freud apparently regarded cannibalistic episodes as integral to the beginning of modern religion. In *Lord of the Flies,* the most shocking sequence is that in which the preparation of boy and pig becomes confused.

Finally, we can't forget the young people inveighing against police with the epithet "pig." They may have been acting out a basic atavism and really screaming the ultimate primitive threat.

A. R. Liboff
Chairman, Department of Physics
Oakland University

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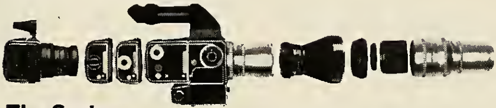

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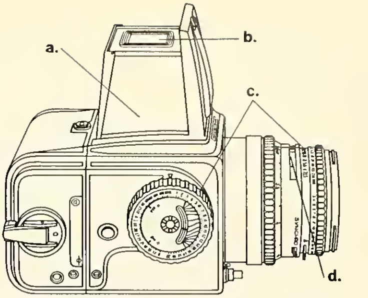

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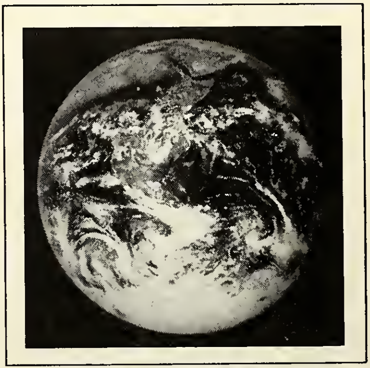

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by Salvador E. Luria

Genesis

Billions of years ago, a nucleic acid molecule learned to replicate itself—and life was on its precarious way

Like artifacts of the past that survive to become antiques, the organisms that are alive today represent an exceptional sample from a large range of possibilities. It will help to understand life—and evolution, which is the central feature of life—if we reflect about human history and look at it, not as the complete record of past events, but as the incomplete record of possible events that might have occurred. Unlike classical academic historians, modern historians inquire why certain events occurred and others did not; what economic forces, personalities, and chance happenings shaped the unique course of human affairs, selecting out of the myriad of potential events those that came true.

In addition, it is important to understand another quality of such historical processes, their irreversibility. Each present, each cross section of history in time, is the unique outcome of the events of the past and, at the same time, the bottleneck of the future. Unexploited past opportunities may present themselves again, but if they do, it will be in a new context, under new circumstances, to new generations whose lives and cultures will be the products of actual experiences that have left their imprint on the present and the future.

Like human history, life too is a historical process. The living organisms of today are the incomplete record of the possibilities of the past. The smallest bacteria, the humblest worms and snails, the algae and mosses, as well as the stateliest trees, the most beautiful birds, and the billions of human beings, are a small sample of the total range of living things that might have existed. Individuals often experience a nostalgia for what might have been, a longing for past opportunities either missed or never available, and even more often, a longing for horizons that might have opened up if only. . . .

And yet, how many ever stop to think how remarkable it is that they exist at all? Each human being is the actualization of an extremely improbable chance—in fact, of a series of improbable chances that extend back billions of years to the beginning of life on earth.

The forms of all living things evolved by natural selection as stages in a perennial blind struggle for the perpetuation of life on earth. By the time cells and multiple-cell organisms had come into existence, the lines were drawn. The fossil record shows that about 400 million years ago all the major groups of animals and plants now in existence were already represented by recognizable ancestors.

Was natural selection always the rule? Or was there a time when the evolution of life proceeded, not by the selection of the more favored types among the descendants of existing forms, but by the addition of new forms arising from nonliving matter—not only by the expansion and differentiation of the old, but also by the creation of new life?

According to the views of most cosmologists, the universe started about fifteen billion years ago with a "big bang," an explosion out of which energy and matter emerged. Whether this occurred from the collapse of a preceding universe or from a collision of matter and antimatter is an irrelevant question to the biologist, for life did not exist at that time. For billions and billions of years, matter and radiation energy evolved physically and chemically. Galaxies, including our own, the Milky Way, came into being, and many of them disappeared. In the condensing clouds of matter, stars—fiery balls that in turn exploded or cooled—were formed. In the stars the simpler atoms collided, fused, produced heavier atoms, and emitted radiation energy, like the light of the sun that now supports life on earth. In the gravitational fields of some stars, satellite masses of matter that had already cooled beyond the stage of atomic fusion condensed and produced planets.

On at least one planet of one star—the sun, which is now five or six billion years old—physical and chemical conditions developed that made it possible for life to begin. Whether this situation was unique or whether, as cosmologists and physical chemists argue, a chemical path to some form of life is bound to be set in motion wherever in the universe the right physical and

For life on earth to arise, components of proteins had to synthesize from organic chemicals. Crystallized hemoglobin protein, left, is shown ×21,600.

From Life—The Unfinished Experiment. *Copyright ©1973 by Salvador E. Luria. Published by Charles Scribner's Sons.*

ROMAN VISHNIAC

chemical setting exists may never be answered.

Even by cosmic standards, the beginning of life on earth is not a recent happening. Half a billion years ago the oceans teemed with an enormous variety of plant and animal life, already preparing to conquer the drying land. Photosynthesis, the machinery for trapping the energy of sunlight, had long existed, and algae had flourished for millennia. But what about earlier? The primitive earth, a mass of steaming vapors, had gradually cooled until rocks had formed in its mantle. The cooling had to go much further before steam became water and the oceans came into being. In time, this water became, in the words of the twentieth-century British biologist J.B.S. Haldane, a "hot, thin soup," a solution of thousands of chemical substances that could support the beginning of life.

Under the physical action of heat, electrical sparks, and ultraviolet light, carbon, nitrogen, oxygen, and hydrogen had combined to produce a variety of compounds. Among them, scientists believe, were also the simplest components of present proteins and nucleic acids. Today the chemist can reproduce in a test tube this prebiotic synthesis of the building blocks of life—amino acids and nucleic acid components—from carbon dioxide, ammonia, cyanogen, and other simple substances.

If life developed only on earth (as I believe) and not on the moon, Mars, Venus, or Jupiter, it was because only earth had the right conditions: the right size, distance from the sun, and mixture of gases in the atmosphere. Earth was fit for life, so life arose. But how? Cells as such could not have come into being directly in the hot, thin soup, since a cell is an enormously complicated object. It is a piece of machinery perfected to do a superior job of the business of living—to provide an optimal milieu for the synthesis of the molecules of life, just as the body of man provides an optimal milieu for the cells of his organs.

Evolution already had a long history before cells came into being. In the watery solution of prebiotic organic chemicals, catalysis brought about the synthesis of complex molecular species of all sorts, including proteins and nucleic acids. The nature of these primitive catalysts, which acted before proteins came into existence, is not known. Almost certainly, clays played an important role: chains of amino acids can be produced in the test tube in the presence of certain types of clay. When seen through the prism of science, the biblical reference to the molding of man out of clay, "I also am formed out of the clay," Job 33:6, may contain an element of truth. Clays are remarkable substances, made up of microscopically thin plates with water-seeking chemical groups on each side. These chemical groups are probably the catalytic agents—the pre-enzymes of the distant past—relatively unspecific yet of tremendous use in the creation of life.

We can only speculate how many millions of times molecules arose that might have given a start to the mainstream of life and how many of them were successful. In order for life to evolve, a form had to come into being that could direct its own replication. Today that role is restricted to nucleic acids alone. Most geneticists believe that the successful starters in the early history of life were nucleic acid molecules, which, by a process of autocatalysis, could help similar molecules to assemble. Early amino acid polymers, possibly made with the help of clay, might then have been replaced by true proteins, that is, by "meaningful" amino acid chains made by translating a nucleic acid template.

But the truly creative advance—the one that may in fact have happened only once—occurred when a nucleic acid molecule learned to direct the assembly of a protein, which in turn helped the copying of the nucleic acid itself. In other words, a nucleic acid served as a template for the assembly of a nucleic acid polymerase. With this development, the first powerful biological feedback mechanism had come into being. Life was on its way.

I mentioned earlier that the story of evolution is the record of the few lines of descent that managed to come into being from among the many that might have been. How much more loss of potential life must have occurred in the billions of years of precellular evolution? Billions of times molecules must have been formed that might have

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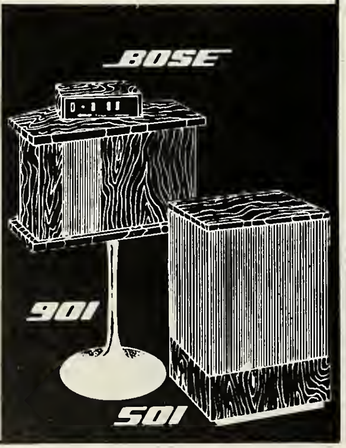

reached the stage of self-replication but did not. Of those that did, how many were able to continue the process? Is life, as it is known from the present array of living things and from the fossil record, the outcome of a unique line of descent from a single molecule among the molecules that learned to reproduce themselves? One primeval gene could have evolved by joining with its own copies, which then became different from their parent (the primitive reproductive process probably being anything but accurate) and gave rise to new genes and groups of genes. Other alternatives are also conceivable. A nucleic acid capable of generating a protein that helped copy it could have provided the replicating mechanism for other, independently arisen nucleic acids. These various nucleic acids could then have become associated in a more easily reproduced complex.

Whether the lineage of life on earth arose only once from the prebiotic chaos or whether multiple events converged to generate complexity will probably never be known. Either way, precellular evolution must have been extremely slow, since the chemical syntheses were without doubt exceedingly inefficient. The great speed-up must have started with the invention of the cell, which provided the efficiency of an organized chemical factory. Cells also may have evolved many times and in many places. Nevertheless, there is no reason to doubt that all organisms have stemmed from a single successful cell lineage.

Some mergers may have taken place: mitochondria and chloroplasts are believed to be remnants of bacteria that became associated with other types of cells to create unions capable of exploiting the oxygen of the air or the light of the sun. But this must have happened hundreds of millions of years after the origin of cells, when a variety of cell types already existed. At one time, students of evolution thought that bacteria resembled some primitive form of life. But a bacterium, with its thousands of genes and enzymes and its remarkably refined adaptations to its environment, is far from primitive.

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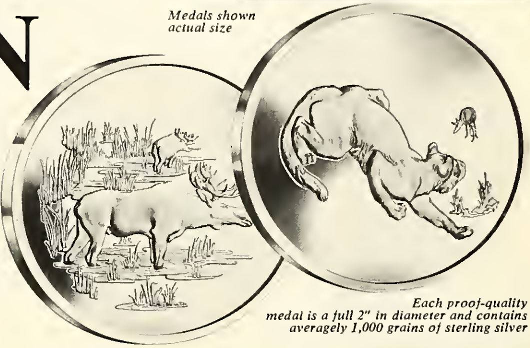

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other planet, will a sample of the earliest forms of life be available. Once a successful line of descent arose, it must have spread so rapidly—that is, in one or two billion years—as to pre-empt the vital space in which any other line might evolve. If life at the molecular level were to start today, it would have no chance to flourish.

In fact, it could not even get started. The conditions that made the start possible no longer exist, for as life spread, it used up the store of prebiotic organic chemicals. Then only those forms of life could survive and prosper that were able to synthesize the needed pieces anew from inorganic substances, such as carbon dioxide and ammonia or nitrogen gas, and thus were no longer dependent on the primeval soup. The world is no longer a soup: even if new organic matter could come into being by processes like those of the early days of the earth, myriads of organisms are now present to make it their food and assimilate it into their own substance.

Thus, not only did its environment shape life, but life shaped that environment and in so doing assured its own undisputed triumph. Yet that triumph was but the opportunity to continue to evolve, life always surviving by the skin of its teeth. Time and again, conditions became critical. New inventions, by mutations and recombinations of the genetic materials, were the key to survival. Consider the history of the devices by which organisms obtain energy for life. Each of these—fermentation, photosynthesis, respiration—was an improvement over the preceding one. But none of them could have become established if the inadequacies of the previous device had not brought the organisms to impending starvation. Evolution works by threats, not by promises, yet its result is the opening of greener and greener pastures.

Photosynthesis, for example, was a crucial jump in chemical evolution; it enabled cells to re-create within themselves something resembling the primeval soup of organic substances, using the same force that created the soup in the first place—the energy of sunlight. Life was thereby made independent of its early environment and ready to conquer the earth.

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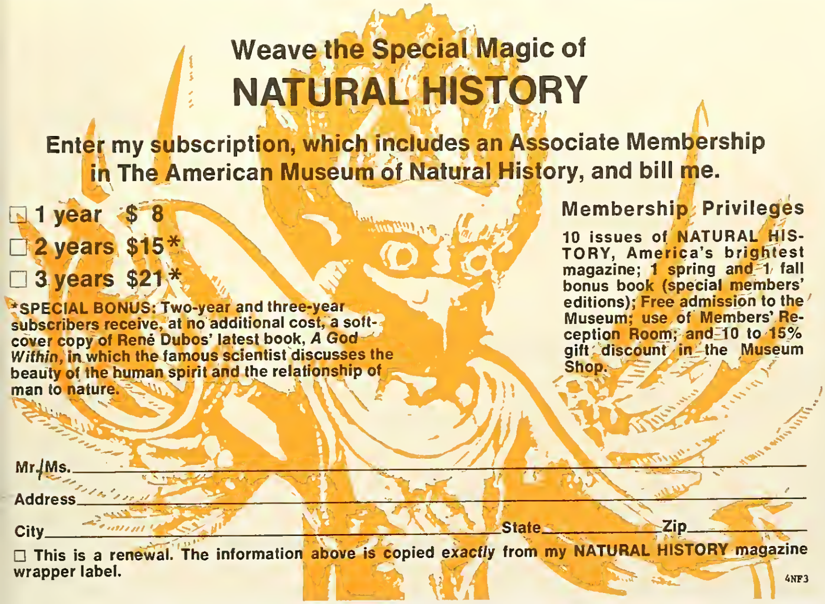

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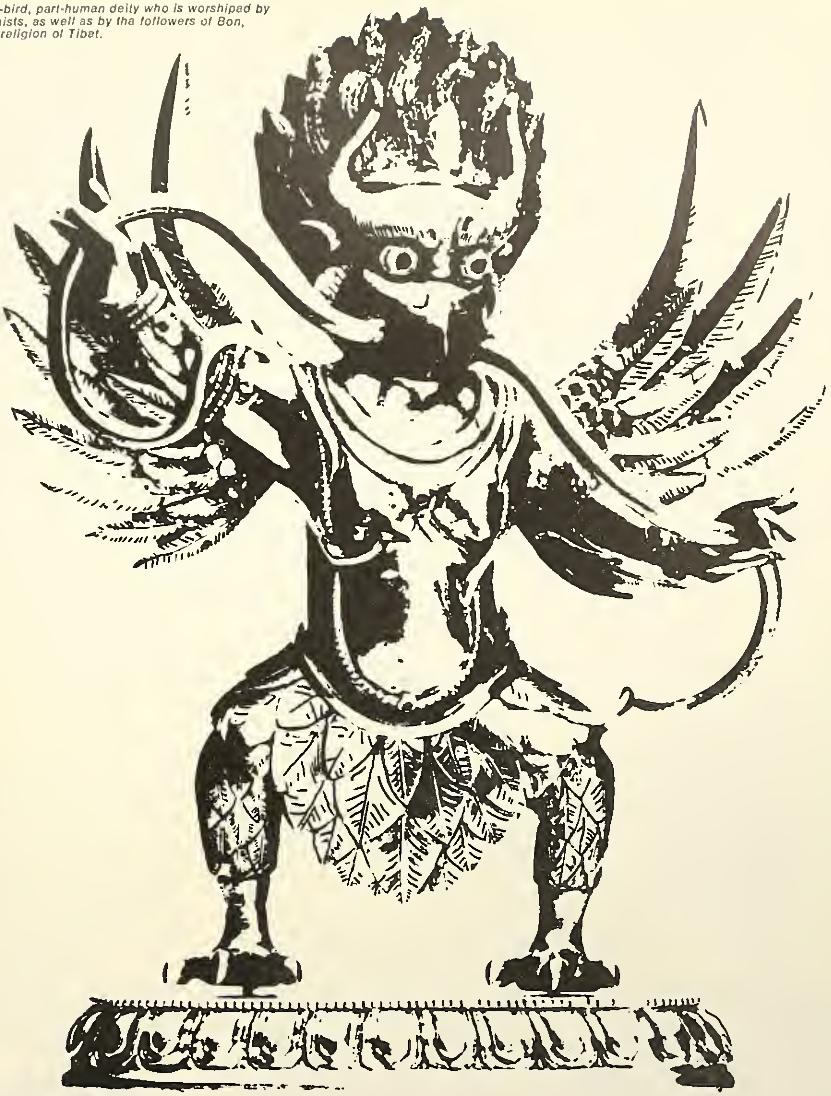

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Thus the cycle goes, green plants producing oxygen and using carbon dioxide, animals doing the reverse. The balance of the whole sustains life. But it is always a precarious balance. When a lake or stream receives too much organic matter, microbes and algae increase disproportionately, using up the oxygen faster than it can diffuse in from the air, and the fish start to die. Life flourishes when balance persists, but imbalance and danger—themselves the agents of natural selection—always loom.

From its beginnings, through many successes, life on earth traveled its precarious path, driven by natural selection, pushed by necessity, bereft of a goal, unobserved, and uncomprehended. Life had to wait for man to appear before any of its creatures asked the questions: What is life and what am I? Some men have believed, self-flatteringly, that man himself was the goal, that what evolution aimed at, what life meant, what the entire universe strove to produce was man, with his consciousness, his inquiring mind, his dissecting reason. I prefer to be more humble. Man is but one product, albeit a very special one, of a series of blind chances and harsh necessities. As with all evolution's creations, his biological fate is to make do, to survive as a species. The skills provided by man's brain, itself perhaps the most marvelous achievement of evolution, can help him pull through—if he does not use these skills to maim and destroy himself and his environment. But he cannot escape his biological fate,

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just as earth and sun cannot escape their cosmological destiny to develop, flourish, age, and perish when their energy is spent. How long can man last? Ten thousand years? a million? ten million? Certainly many fewer than the few billion years of active radiation left to the sun.

Within the time span of man's existence on earth, he can hardly plan or hope to escape this planet's boundary by colonizing new worlds. The sun's other planets are not only uninhabited but, biologically speaking, uninhabitable. They may permit some technologically maintained life—in a lunar laboratory for example—but they cannot support the evolution of earthly organisms. Man's evolution has occurred on earth, is marked by the earth, and cannot be exported from it. At best, the planets he has begun to explore can serve him as colonies traditionally serve the empires that conquer them—as sources of pride, outlets for the restless, and drains of emotional and other resources.

What about the farther worlds, planets of distant stars that may support life, possibly even intelligent life? It is widely believed that life will have arisen and developed wherever conditions were suitable for it—possibly on millions of planets of as many stars. If this is true, will man ever know where these planets are in space or be able to communicate with their inhabitants? Twenty years ago, when radio astronomy was in its ambitious youth, radio telescopes were programmed to "listen" for signals from the great beyond, scanning the sky in the direction of stars that might have planets similar to earth; whose inhabitants might be broadcasting intelligible signals into the universe. Such signals were expected to reflect intrinsic properties of matter or thought-series of integers or prime numbers or formulas describing the laws of physics.

No signal was detected and the program was stopped, although it may soon be reactivated. But the lure of the unknown remains. Are men, as conscious, inquisitive beings, unique in the universe or not? Whatever the answer, surely man can be proud that he has come far enough in biological evolution to ask such questions. ☐

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Health Care in North Vietnam

Despite the war, the DRVN has reduced its death rate and controlled many once rampant diseases

Like the educational system in the Democratic Republic of Vietnam (described in this column last month), that country's medical facilities are efficiently mobilized and remarkably appropriate to the needs of a nation at war.

Clearly, a small, postcolonial Asian nation cannot sustain a first-rate scientific research establishment while fighting a war of attrition against superior Western powers. The medical science that I had the opportunity to observe during my 1971 visit to Hanoi and environs was of necessity applied but nonetheless impressive. Not only had it survived several decades of war, it had continued to train new personnel and expand its services. What is more, this scientific effort had proved to be indispensable to the war effort.

Health care in North Vietnam is directed by the Ministry of Public Health. Its achievements were spelled out for me by Dr. Le Van Phung, Director of Hospitals, in some statistics he supplied during my visit to the Ministry.

Under French colonial rule, cholera, smallpox, trachoma, malaria, venereal disease, and leprosy were rampant, and infant mortality high. There were only forty-seven hospitals in the entire country, and one doctor per 180,000 population. By 1971, these statistics had changed dramatically. There was one doctor for every 7,000 individuals, and if auxiliary medical personnel are included, there was one for every 1,600. The annual death rate had been reduced from 26 to 7.6 per thousand, maternal mortality from 20 to 0.8 per thousand births, and neonatal mortality (first month of life) from 300 to 26 per thousand births. Cholera, polio, typhoid, paratyphoid, smallpox, and plague had been brought under control by vaccination. The incidence of trachoma had been reduced from 80 to 40 percent and that of malaria from 9 to 0.14 percent. Malaria had been controlled primarily with DDT supplied by the Soviet Union, but because of new, resistant strains of mosquitoes, the disease was again on the rise. The incidence of leprosy had been reduced from 2 to 1 percent, although facilities for leprosy treatment had been diminished when the world-renowned 2,600-bed Quynh Lap leprosarium was destroyed by repeated aerial bombardment. The incidence of tuberculosis had declined from 4 to 1.5 percent, partly through development of a heat-killed variant of the standard BCG preparation that makes storage and transport easier. Venereal disease had been reduced to several hundred cases a year, primarily because prostitution had been banned.

The basic unit responsible for this progress in public health is the village maternity clinic. In 1971, there were 6,000 of them compared to 200 in 1955. Almost every village in the country has such a clinic, usually staffed by at least one doctor, an auxiliary doctor, a midwife with two to three years' training, a nurse, and a pharmacist.

These clinics have improved sanitation practices throughout Vietnam by promoting the use of two technical advances, shown to us in scale models by Dr. Phung. The first innovation was a new type of double-compartment privy that combines sanitation with production of economically valuable fertilizer. Only one compartment is in use at a time. Urine is led off separately, and feces collected in a compartment to which a sand and ash mixture is added after each use. When that compartment is full, it is hermetically sealed and the other compartment is put into use. After two months' anaerobic incubation of the first compartment, during

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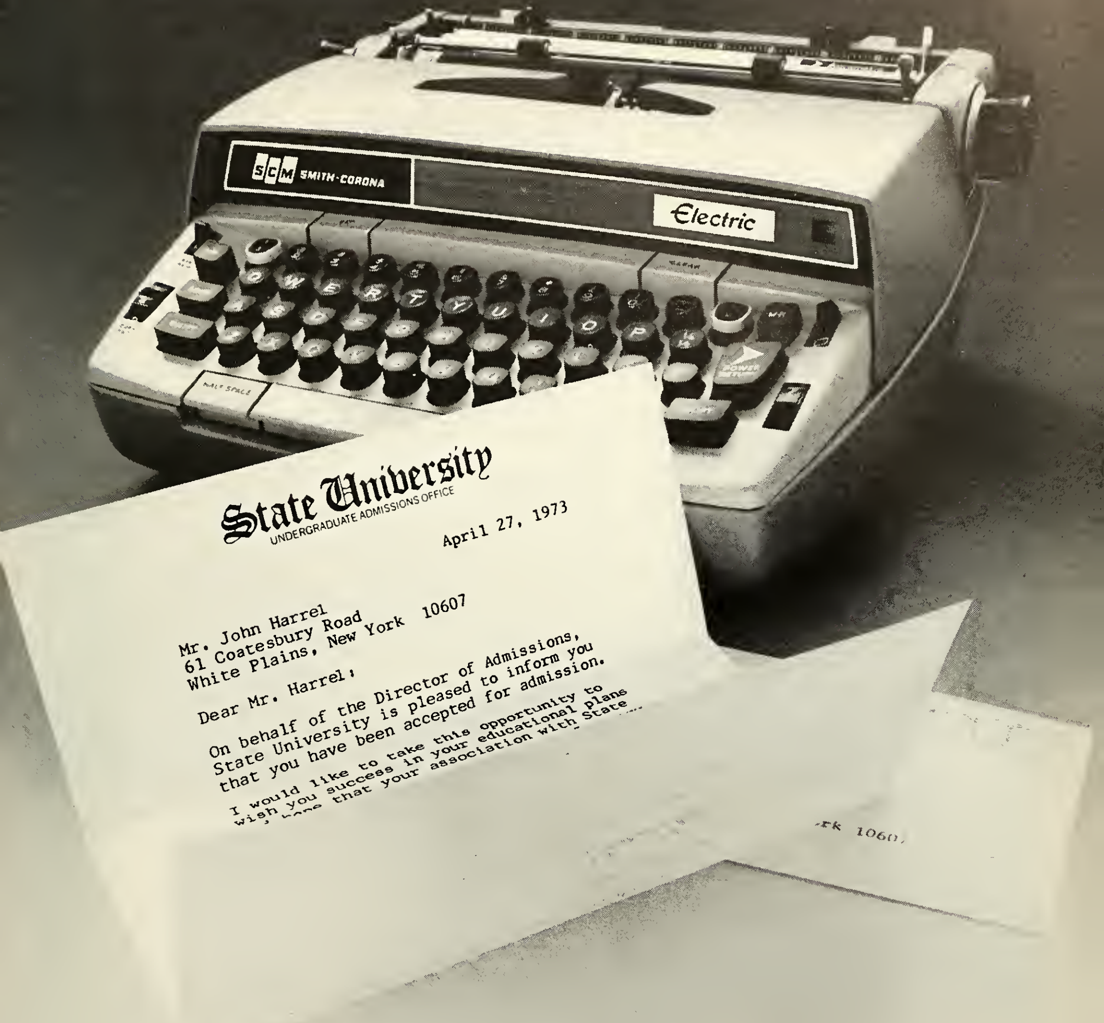

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which all parasites are killed and odors destroyed, the residual material is removed and used as fertilizer. The second compartment is then sealed off, the first returned to use, and the cycle is begun again. Except for a small section of Hanoi that has a sewer system, the entire country now employs such toilet facilities.

The second innovation insures supplies of clean drinking water. Family groups of two or three are taught by the clinic to dig a good well with watertight stone-lined sides. If the water table is too deep for a well, they filter swamp water through a sand-filled channel.

The network of clinics forms the first level of a pyramidal system, which progresses to district, then provincial hospitals, and includes special dispensaries for diseases such as trachoma, tuberculosis, and leprosy. In addition to their treatment facilities, the provincial stations have become record centers for the National Institute of Hygiene and Epidemiology for potential and actual epidemics as well as individual case histories. The institute also operates mobile units for immunization programs and distribution of public health information. In Hanoi the institute's mobile units collect samples and handle all preliminary laboratory work for epidemic control.

Despite the war, the population (21 million in 1971) has been increasing annually by about 600,000, or 2.8 percent. Since this rate is considered too rapid for optimum development of the country, birth control information and contraceptive supplies such as condoms and intrauterine devices are dispensed through the village clinics. Abortion by dilation and curettage is available on request at the district hospitals.

Many special measures were instituted to maintain health services during the air war. Dr. Phung described how casualties were minimized through trenches, camouflage, and bomb shelters, as well as by dispersal of buildings and people (as with the Agricultural College mentioned in the May article on wartime education in the DRVN). One village in the demilitarized zone, although hit with 430 tons of explosives in 180 bombardments, had suffered only six dead and

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twenty-nine wounded by 1971 because of efficient use of bomb shelters. Casualties were treated by a four-level network. Medics in each village dug out collapsed shelters, resuscitated victims, tied tourniquets and set splints, and moved patients to the village clinics when necessary. There, transfusions and treatment against shock could be given and minor wounds treated. Surgical cases were evacuated to the district hospitals, all of which could perform routine operations. Cranial surgery, however, was performed only at top-level provincial hospitals. Because of the war, all medical students are now trained in surgery.

I learned still more about medical care in the DRVN from Dr. Ton That Tung of the Viet Duc Huu Nghi Hospital. A former vice-minister of public health, this vigorous, forceful man has been designated a "Hero of Labor" and is highly respected by the entire scientific community. He trained in Hanoi as a surgeon and is now a member of the Surgical Academy in Paris and of the Academy of Medical Scientists of the Soviet Union. During the anti-French resistance, he founded a hospital in the forest, which led in 1954 to the establishment in Hanoi of the present 350-bed facility used as a surgical training clinic for the medical school of the university.

The Hanoi University medical school is the only medical school in the DRVN. It graduates three hundred to five hundred doctors a year. The course takes five to six years following secondary school. Formerly, students were employed in the hospital doing routine chores during their first year, as in the French system, but the war and the necessary dispersal of facilities have forced the adoption of the American system in which students do not enter the hospital until their third year. Dr. Tung feels this is less desirable as it deprives students of early contact with patients and thus the opportunity of better understanding them.

In addition to the university medical school, twenty technical schools throughout the country each year train eight hundred to a thousand paraprofessional personnel (called "feldschers," as in the Soviet Union) in a three-year course. For the first time these schools are supplying enough nurses as well.

Although housed in modest quarters, the university hospital seemed clean and well run. Most of the equipment came from the Soviet Union, China, East Germany, and Hungary, but there was also some from France and Great Britain and even a few oxygenators from the United States. The latter were rarely used, Dr. Tung said, because they waste precious oxygen. The hospital had recently received the gift of a heart-lung machine from the American Friends Service Committee, for which Dr. Tung repeatedly expressed his appreciation. However, the hospital needs more standard equipment and suffers a chronic shortage of medicines, especially methotrexate, isoniazid, streptomycin, and antibiotics.

Continued on page 76

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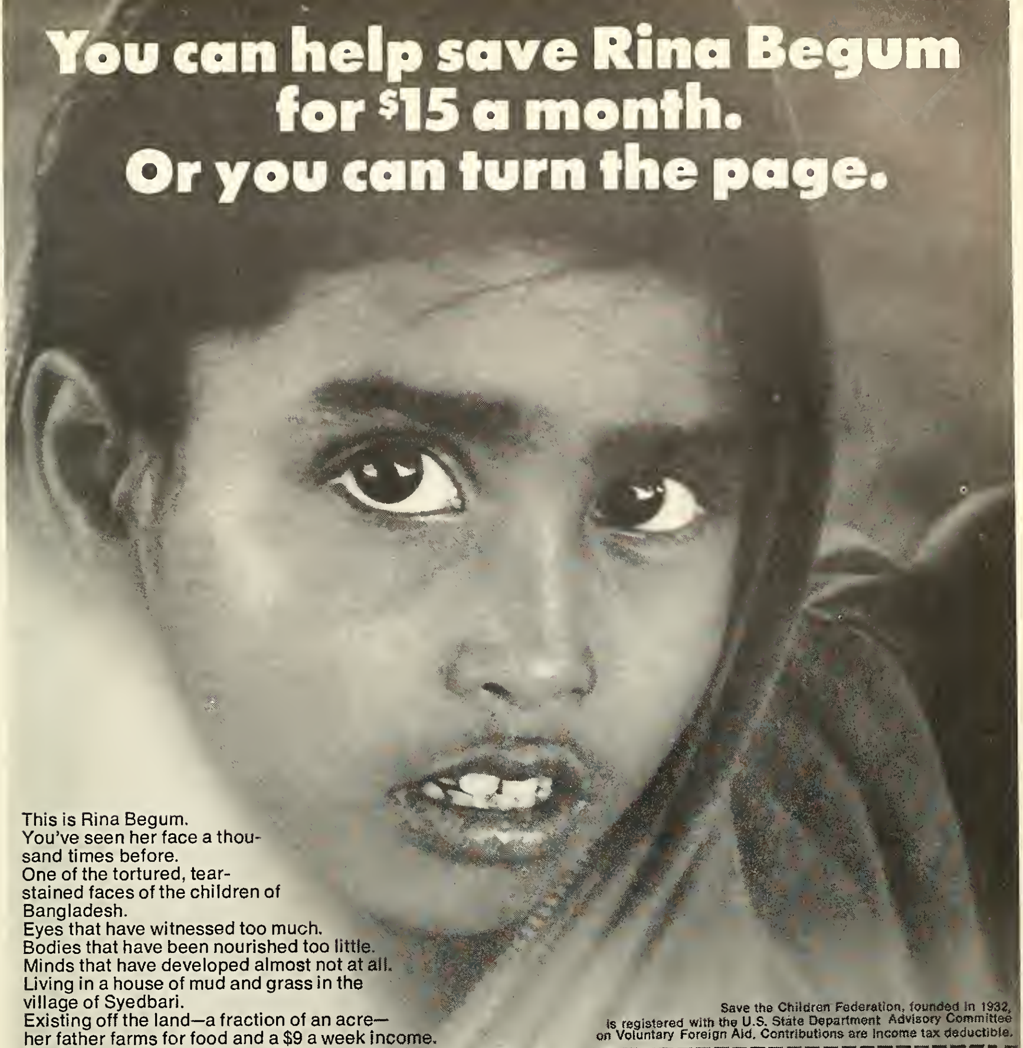

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Old Glory and the New

Caught in the crosscurrents of international politics, a once great Pacific culture is foundering

by David Labby

There was a time when the island of Yap, in the Carolines, was the core of an island empire, and from a chain of atolls that reached far across the western Pacific, huge oceangoing canoes brought tribute to Yap's chiefs. In return, the Yapese watched over the people of these smaller, poorer, less protected islands, and allowed them the use of Yap's more plentiful resources.

Today that empire has been submerged in the currents of global politics and economics. Yap itself is now a part of the United States' island empire. Micronesia, the Trust Territory of the Pacific Islands created by the United Nations in the aftermath of World War II. Battles such as those on Eniwetok, Kwajalein, Saipan, and Truk made clear the strategic military value of the more than two thousand, large and small Pacific islands that Japan had held under a mandate from the League of Nations. Scattered through an expanse of ocean as large as the continental United States, the territory includes three different island chains, the Carolines, the Marshalls, and the Marianas (except Guam)—all of Micronesia except the Gilberts—and provides an important focal point in the Pacific between Asia and the Americas.

Having captured the islands, the United States lobbied in the United Nations to have them declared a "strategic trust" under its control. This was a unique arrangement that went beyond the usual agreement

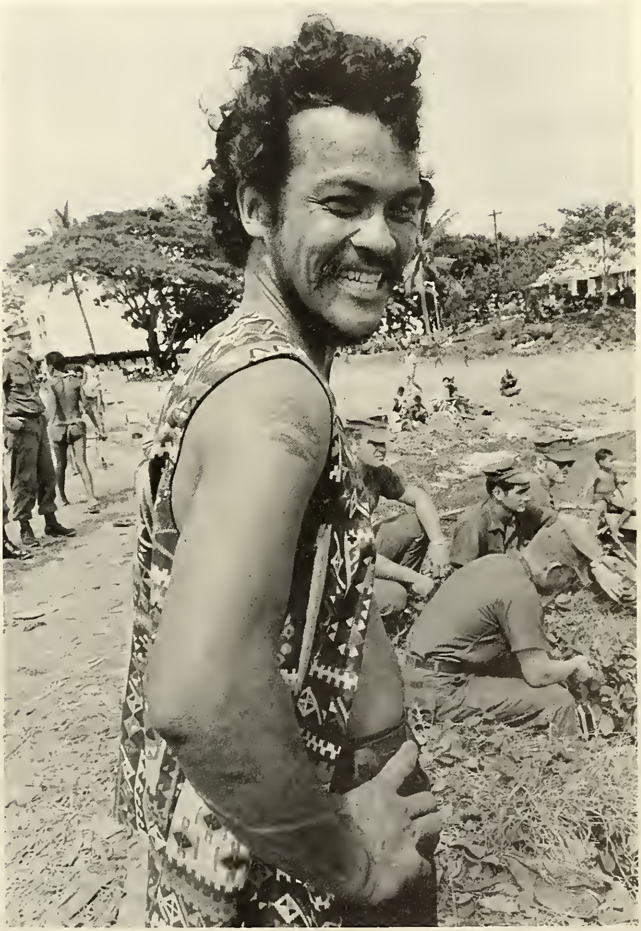
Yap

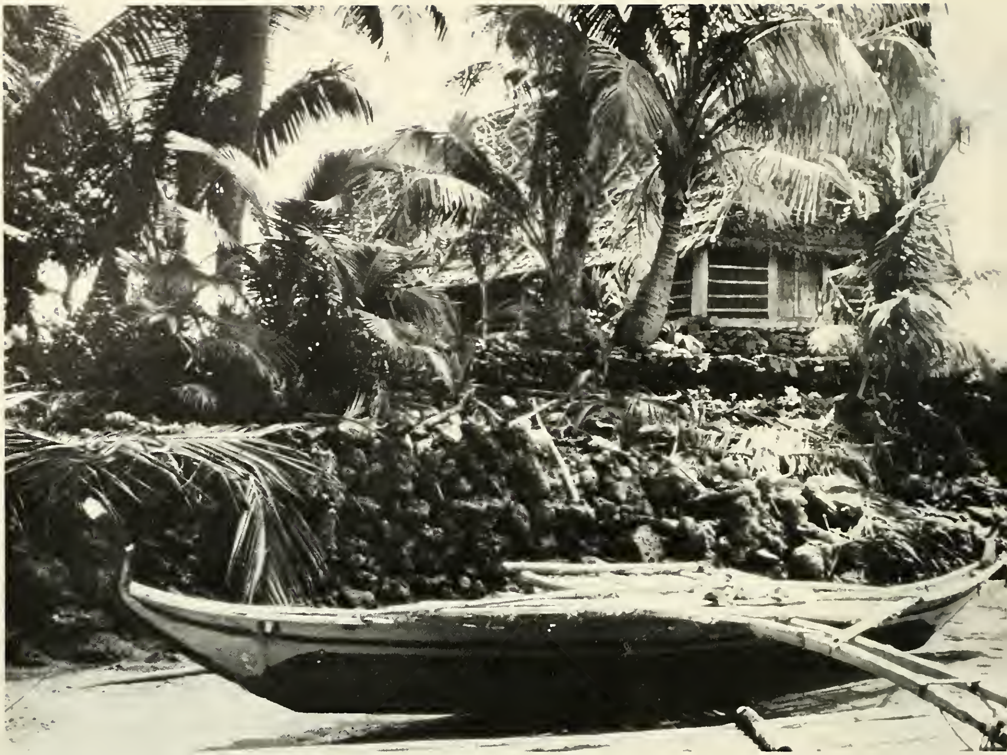
Photographs by Dorreen Labby

binding the trustee to oversee the political and economic development of the area toward "self-determination or independence." It further allowed the United States to build any military installations necessary for "the maintenance of international peace and security."

Translated into the concrete terms of modern politics, the arrangement has meant that the people of Eniwetok and Bikini were removed from their islands to allow for nuclear testing, that Kwajalein has been turned into a missile testing range, that some 60 percent of the territory's land resources have been retained by the United States as "public land," which has been or may be appropriated for civilian or military use, and that from 1951 to 1962 one-half of Saipan in the Marianas was sealed off by the CIA as a secret base.

It has also meant that the United States has been somewhat less than eager to allow the more than 100,000 inhabitants of this strategic area to move toward independence or self-government. In fact, when Australia grants Papua New Guinea independence on December 1,1973, ten of the eleven trust territories will have achieved self-determination, leaving only Micronesia still under foreign administration. For several years negotiations concerning the future political status of the territory have been under way between Micronesian political leaders and the United States. However, when the Micronesian de-





legation began discussing the possibility of complete independence at the latest round of meetings held in Hawaii in September, 1972, the United States broke off the talks.

The territory's political dependence is just one aspect of American administration. Another is the steady erosion of traditional culture as the territory's inhabitants increasingly adopt American values and institutions.

During the two years my wife and I spent on Yap, we lived in several Yapese villages and, for a brief time, in Yap's growing capital, Colonia. Yap has had the reputation of being the most conservative of the six island districts in the trust territory, in part because until twenty years ago the Yapese hesitated to move into Colonia and participate in its economic life, and in part because the Yapese have maintained their traditional dress longer than many other island people. A visitor to Yap can still see women in grass skirts walking along the main road near Colonia or a plane being refueled by a man wearing an elaborate loincloth decorated with a looping hibiscus belt.

Yap has not been modernized to the extent of larger islands, such as Saipan, which are more attractive for trade and colonization, but neither has it remained unchanged, like the smaller atolls of the isolated outer islands. In many ways, Yap strikes a mean between extremes, and the social conditions there can be taken as representative of Micronesia as a whole.

Before Yap first came under continual foreign administration in the late nineteenth century, the island supported an estimated forty thousand people. Working the land and sea, they used these resources as they had been transformed and developed by the generations who la-

Outrigger canoes, now used as showpieces on Yap, are still common on the isolated outer islands. Today, most Yapese use outboards for fishing and transportation. In the background is a men's house—most of these were destroyed during World War II.

Children in the traditional villages are raised by all the adult members of the extended family. Older children are taught to assume responsibility for younger brothers and sisters.

bored before them. Huge, arrow-shaped, stone fish traps had been built out into the lagoon, and thousands of wet taro patches—shallow, square, muddy pits that produced Yap's basic staple—had been laboriously excavated out of the coastal flats and irrigated by fresh water channeled down from the central hills. It is only since 1945, when the United States began governing the island, that the Yapese have begun to give up these traditional occupations.

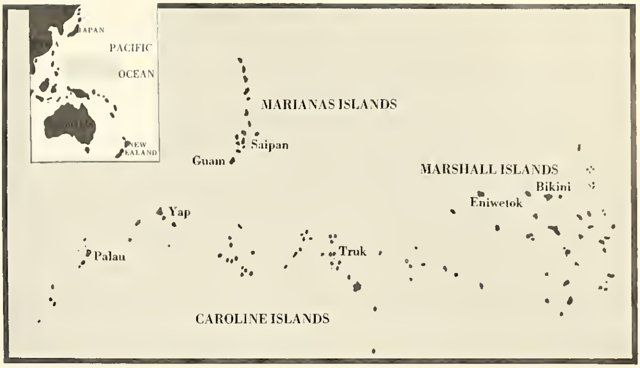
In the past, most of the 130 or so villages on Yap were located behind dense mangrove entanglements close to the shore. Here the land is fertile and the villages stood amid a luxurious green enclosure of coconut palm, banana, papaya, mango, breadfruit, betel, and tropical chestnut. But not all of Yap's 37 square miles are equally productive; the inland hills range from grassy rises in the south, fertile enough to support extensive yam gardens, to an unproductive plateau, with acres of totally barren badlands, in the north. Consequently the pattern of life reflected the premium that had come to be placed on rights to land and sea resources.

Every piece of land, every tree, every bit of fishing area inside the reef surrounding the island was owned. A hierarchy based on land ownership developed, and villages were divided into two major social strata, that of the landowning "chiefs" and that of the landless "servants," and subdivided into seven ranked levels. Each household within the village was ranked, as well as each individual within the household, on the basis of its rights to land.

Traditionally, the village was the center of Yapese life. In it, each family group worked its own gardens and taro patches and fished its own sea plots, occasionally joining together under the direction of the village chiefs for a communal project.

Today a large number of these villages have been abandoned. Walking along any of the island's interconnecting paths, one can see scores of overgrown house foundations, raised rock platforms that once supported high-peaked Yapese houses. Hidden away in the dense stands of coconut palm and tropical vegetation, an occasional old couple or family keeps their ancestral village alive.

Two such isolated villages are



neighboring Gilfith and Rang, where we stayed for five months in 1970. At the time, ten families, who followed many of the old customs, lived there. Two magnificent men's houses, rebuilt after the war on coral platforms in the lagoon, were being used for meetings, drinking parties, making preparations for fishing, and sleeping. Women were not allowed to wear Western dress within the boundaries of the villages, and during menses they were still required to seclude themselves in the *dapal*, or menstrual huts, some of the last on Yap. The family we lived with in Rang followed the old eating class system based on *tabugul* ("purity") and *taay* ("impurity").

Men were *tabugul* with respect to women, who were *taay* in that they menstruated and gave birth to children. A man's food was harvested from a separate piece of land from that of his wife or children. It was cooked in a separate cookhouse and eaten with separate utensils. The family we lived with still had five separate cooking areas, two for the adult married brothers who shared the house, one for their aging mother, one for their wives and young children, and another for their young unmarried daughters.

The family's daily existence was based on the old ways. In the morning the women set out for the gardens with their digging sticks and large coconut frond baskets, the youngest children trailing behind them. The men gathered at the men's house where they prepared for fishing or repaired nets and boats. But the village adults were getting old. Some of their children had already left the village for jobs in town. Others were at the island high school or the municipal elementary school learning new values and skills that would draw them away. The village was no longer the self-sufficient and active community it had once been.

All day the wide main path through the village was deserted. At dusk, the family members returned from their various activities and the women cooked taro, sweet potatoes, and yams at the different coconut husk fires and kerosene stoves. After the evening meal, the whole family gathered at the main house to talk and chew betel nuts; the children played or did homework, and the women wove or shredded palm leaves for grass skirts.

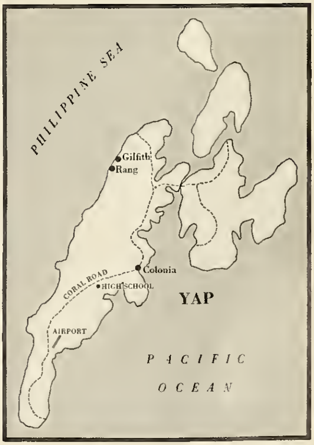
I had expected that the people of these two villages would be more knowledgeable about their customs than other Yapese. For the most part, however, the traditional patterns were still being followed, mainly because some of the older people insisted on them.

Many of the elderly people in the villages found themselves increasingly cut off from their children. While they disapproved of much of the Americanized town life, they wanted their children to succeed in it and encouraged them strongly in their education and jobs. Most said they followed the customs simply because they were too old to change and realized that they could not expect their children to do the same.

To the young people many of the traditional practices seemed unnecessary, and life in a remote village was unattractive. Most of the girls resisted going to the menstrual huts and, if they could, "secluded" themselves from the village by going to town. The young men who had jobs or attended school in town found it too difficult to commute daily and came to the villages only on weekends. The family we lived with admitted that after the aging mother died, they would probably no longer observe some of the old customs such as maintaining many separate cooking areas.

Gilfith and Rang seem to have a doubtful future, but this is not true for all Yapese villages. Some are still well populated and prosperous. Invariably, these are near the central road, which runs through Yap from north to south. Many of these villagers commute by car or bus to jobs in Colonia, and their villages have taken on the character of sub-

A mother and child await the start of a celebration in Gilfith. Frequent celebrations attract those with ties to the villages and serve to reinforce traditions for those who have moved to Colonia.



The Palauans living on Yap were the first to adopt American-style dancing, followed by the more conservative Yapese. Noon hour dances are held at the Yap high school.

urbs oriented to the events and opportunities of the capital, where a large part of Yap's population of 4,000 now lives. Consequently, the villages have ceased to be self-contained social units; regulated by the five-day work week, the villagers find it difficult to keep up their traditional obligations, while chiefs can no longer command the allegiance due them.

The growth of Colonia has clearly affected all levels of Yapese life. The town stands on a promontory next to a large opening in the reef that creates Yap's central harbor. There, for approximately a hundred years, Yap's successive colonial administrations have had their headquarters. Today Colonia is the administrative center of Yap District, an area that includes not only Yap proper but also the outer islands where one-third of the district's 7,500 inhabitants live in relative isolation. Significantly, it is only in the last two decades that Colonia has become the focal point of Yapese life.

Yap has been under foreign influence for 450 years, sporadic at first, with the comings and goings of copra traders, but constant since 1886 when it was first claimed by Spain. After losing the Spanish-American War, the Spanish sold the island to Germany in 1899. At the outbreak of World War I, Germany lost Yap to Japan, and the Japanese lost it to the United States during World War II.

The Germans established the first effective administration on Yap, trained a Yapese police force and army, and used Yapese labor to build roads and a canal, but their plans to turn the island into a colony of copra plantations were cut short when Japan seized Micronesia. The Japanese, in turn, established sugar plantations on Saipan and began fishing, mining, and farming projects elsewhere, but found that the resources of Yap had little potential. A sizable Japanese administrative and commercial colony developed on the island, but the Yapese were only peripherally involved. Although many were required to labor at tasks appointed by the administration, especially during the military buildup of the island before World War II, the Yapese continued to support themselves by traditional patterns. The Japanese, primarily interested in colonization, did not hide their belief that the Yapese were a vastly inferior people who had not progressed beyond a primitive, matrilineal stage of society.

In 1945 the United States assumed control of Micronesia and for the next six years Yap was administered by the U.S. Navy. Colonia remained the center of administration, but it was much smaller and less developed than it had been in prewar Japanese times. The Americans rebuilt the roads and a hospital, and set up an elementary school system. Because inadequate appropriations did little to improve the war-devastated and economically backward area, the Yapese remained generally suspicious of American efforts, and the island quietly stagnated.

American administrators of the island did have one important political asset, however—the Micronesians' remembrance of life under Japanese rule just prior to, and during, World War II. The Japanese broke up houses and canoes for firewood, used stone house foundations

Traditional dance movements, still an important part of Yapese culture, are performed at celebrations honoring the completion of village projects. Over the past few years, however, villages have begun to limit celebrations to two annual holidays.

and even some traditional stone money for construction work, and razed men's houses and meetinghouses lest they be spotted as population centers by American airmen. The Yapese remembered the forced labor and harsh discipline imposed by the Japanese, and they knew that their once vigorous population had come dangerously close to extinction. Diseases introduced by the first Westerners in the area had progressively reduced the population, until at the end of the Japanese occupation there were only about 2,500 people left. The Yapese felt the depopulation resulted from the increasingly difficult conditions of life they had to endure under the Japanese. Against this background, the initial American neglect of the area seemed simply like noninterference, a promising change from previous colonial administrations.

In 1951 the U.S. Department of the Interior was given responsibility for the area. Headquarters were established at Colonia and new public services created salaried positions that could be occupied by Yapese. As job opportunities—in construction and other businesses—increased, more villagers moved to the town and began to participate in the economic life of Yap.

In the early 1960s the United States shifted from its policy of "benign neglect." There was new concern for the area based on its importance to United States security. In 1962 President Kennedy set forth, as American policy, "the movement of Micronesia into a permanent relationship with the U. S. within our political framework." Annual appropriations were increased; from $5 to $7 million they rose in only ten years to the present

$60 million level. With the new appropriations came more American personnel hired to manage the enlarged government programs, the Peace Corps, and most recently, civic action teams from the different branches of the military. As new jobs opened up and shipping and air facilities improved, the new consumer economy reached out to more and more Yapese.

One of the factors that contributed to the rapid social transformation of the Yapese was their concern for social status and mobility. Traditionally, almost all social statuses—chief, priest, or servant—were related to particular plots of land. To increase its standing in the social hierarchy, each new generation of a clan was expected to seek out land of higher status in higher ranking villages. Once employment opportunities became available under the Americans, the same social process could take place in a job hierarchy that offered prestige, power, and economic rewards in a new context.

The expansion of job and consumer opportunities in Colonia during the last fifteen years has transformed the town from an American

A United States Army Santa Claus, a bewildering apparition to many Yapese children, delivers gifts each year at the Yap airport.

administrative colony to a sprawling collection of stores, bars, and shanties. The government buildings and Western-style official residences are still the center of Colonia, but now there is also a new bank and a shopping complex. Cars, motorcycles, kerosene stoves and refrigerators, radios, and wristwatches, the majority imported from Japan, can be bought on time payments or loans, sometimes at high interest rates.

There is constant activity in Colonia's new, urban life. Government and military jeeps, trucks, and heavy road-building equipment cross and recross the town center. On "plane days" buses and trucks head out to the airport to meet the plane, which stops at Yap on its way from Guam to Palau and again on the way back. At five o'clock the bars and stores begin to fill. A steady stream of buses and Japanese cars, their mufflers eroded by the salt in the coral-rock-surfaced roads, rumbles out to the villages. By evening the town has settled down to the noises of the bars and the nightly offering of westerns and war movies.

The Yapese residents of Colonia live clustered in small houses on the hillsides and along the shore. Many of the houses are crude shacks made of scrap metal and discarded packing crates, and most do not have access to public water or electricity. Outhouses extend over the bay, which once also served for bathing. Now it is lined with signs warning that the water is polluted and unsafe. Garbage is simply thrown in the bushes. In these shantytowns the traditional "Yapese" way of life is becoming increasingly distant and irrelevant to Colonia's job market, more and more a mere account of what was once done and once thought. Traditional values, patterns of authority, and sense of identity are weakening, and many Yapese are finding it difficult to cope with the changing world created by the Americans. Problems of drunkenness and juvenile delinquency are common.

At the southern edge of town, along Colonia's harbor, are communities of outer islanders and Palauans. The outer islanders of Yap District come into Colonia to work, visit, or get medical care at the district hospital. Coming from islands that were formerly subservient to Yap, outer islanders are still conscious of the deference behavior required of them on Yap. Many are hesitant to venture beyond their small, crowded compound. They tend to go about only in groups, walking self-consciously into the center of town and back. As if for contrast, the aggressive, urban Palauans with their American-styled clothes and brightly painted cars have established themselves nearby in a well-organized and flourishing community. They live in plywood and sheet metal houses, some with electricity and water.

The Palauans, whose island 250 miles to the south of Yap served as the headquarters of the Japanese, are among the most modernized and technically skilled of Micronesians and were drawn to Yap by favorable job opportunities. As the Yapese have become more job oriented and urbanized, an undercurrent of rivalry has evolved between the two groups, occasionally erupting in street fights and barroom brawls.

Few Yapese, however, lead a completely urban life. Even in town the women continue to provide the family with food from their gardens and taro patches, often making a weekend excursion out to a village to harvest a week's supply. In place of their traditional contribution of fresh fish, men working in town provide the family with money to buy such store goods as canned fish, corned beef, crackers, and canned milk. Because families still rely on women's labor, only a part of the men's wages have to be spent on necessities; a man can spend the rest as he desires, usually on beer.

To the Yapese, Colonia is the frontier of a new kind of life, with a new set of material wants, needs, and satisfactions and a new set of social relations. The opportunities appear unlimited. Money seems easy; the supply of consumer goods, inexhaustible; and the possibilities for amusement, unending. Most Yapese admit that compared to what they experienced under the Japanese or the Germans, life has definitely improved.

Yapese boys clown during a school recess. Paint left over from class provided the facial adornment.

Yet as Micronesian political leaders have perceived, the prosperity emanating from Colonia and the other district centers is only possible at a certain cost. As the Yapese and other Micronesians demand more and more consumer goods manufactured outside the territory, they become accustomed to a life-style they cannot afford on the basis of their own productive resources, at least not as they have been developed under American administration. Roads, bridges, airports, docks, water systems, schools, and health facilities have been built, but except for the establishment of a tuna fishing operation in Palau, the territory's own economic development has been nil. Copra, marine products, tourism, and for a while, scrap metal salvaged from the tons of wrecked military equipment left on the islands after the war have provided some export revenues. Still those revenues do not come close to balancing the cost of the imports Micronesians now demand, much of which are foodstuffs that could be produced locally.

The repercussions have now become quite clear. The Congress of Micronesia, formed in 1964 by indigenous political leaders and patterned after the U.S. federal legislature, has long been aware of the political and economic bind American policy has created for the territory. Toward the end of 1969, negotiations began between an elected delegation from the Congress of Micronesia and the United States concerning the future political status of the trust territory islands. The Micronesians first favored a "free association" with the States, an arrangement by which they would continue to accept the presence of the American military but only at a negotiated price. For many this represented a compromise between the ideal of complete self-government and the present economic necessities. Talks with U.S. representatives, however, have served to delineate quite clearly the nature of American interest in Micronesia, one inextricably tied to its geographical location, and have convinced more than a few leaders that such a compromise is not feasible.

This portrait of a Yapese family sitting against a piece of traditional stone money was taken for a son studying in the United States, who later returned to Yap with an American wife. Stone money, quarried in Palau many years ago, is still used throughout Yap as a ceremonial medium of exchange.

At last summer's special session of the Congress of Micronesia, the review of an incomplete draft of a free-association compact led a majority of members of the Congress to sign a letter opposing it as entailing too great a compromise of Micronesian sovereignty. While the United States had agreed to Micronesian control of land, it had also demanded permanent rights to military bases as well as special "emergency rights" to land. The Congress further instructed its delegation to consider the possibility of complete independence, as well as free association, in the negotiations, leading to the United States' walkout from the political status talks last September.

As the vision of an independent and neutral Micronesia—self-sufficient on its own, as yet untapped, marine, land, and human resources—attracts more Micronesian leaders, the problems facing them become even larger. Since 1970, imports have almost doubled again—to $426 million in 1971—while exports have remained the same at about $3 million. Meanwhile, the American governmental bureaucracy continues to increase. Tourism is beginning to boom with an influx of money from the United States and Japan, but there is no guarantee that Micronesians will share its profits, other than as porters, chambermaids, and "natives."

A Yap Nature Life Park, consisting of a few semipermanent huts and tents for tourist quarters, was recently opened on one of the island's more beautiful beaches by a Yapese entrepreneur backed with Japanese capital. More and more, Micronesians are being drawn into the new economic world without any development of indigenous productive resources to support them, thereby increasing their financial and political dependency.

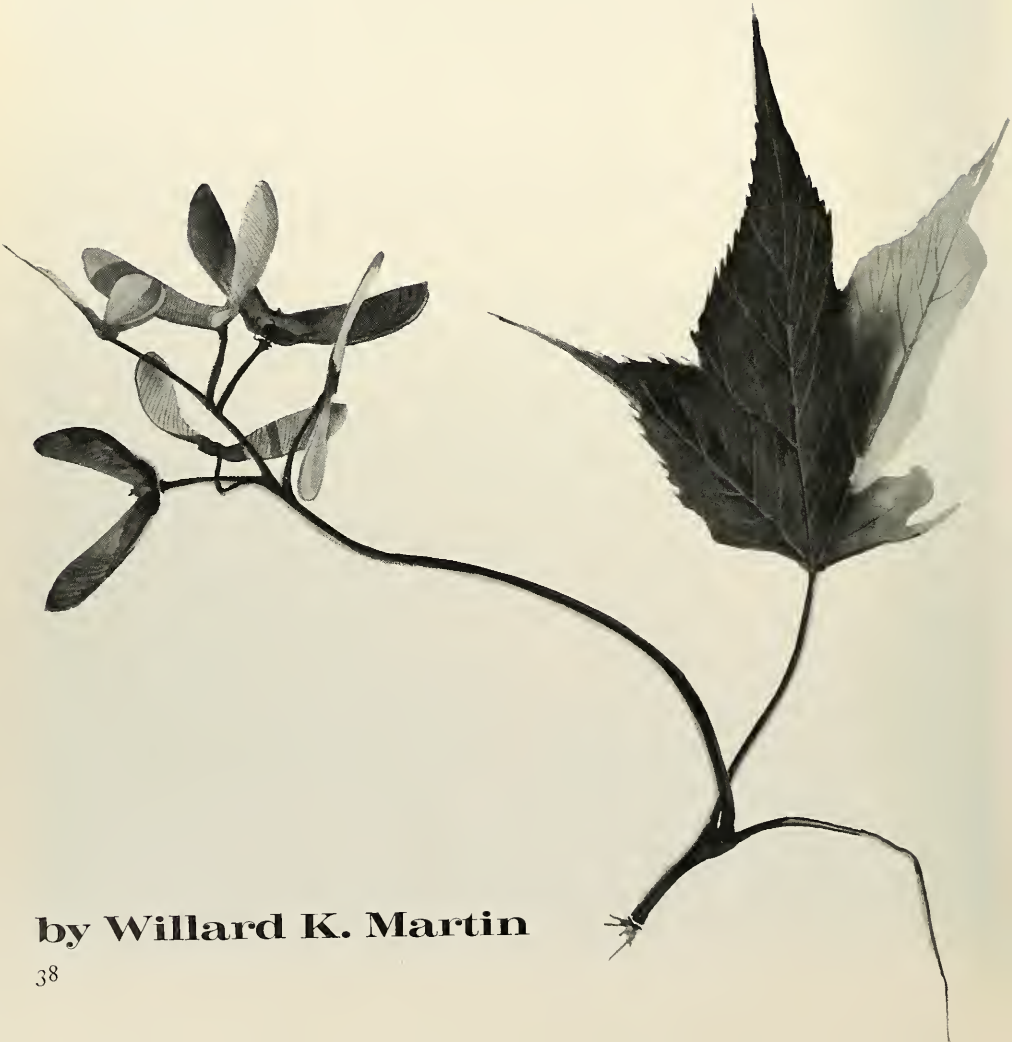
While most Yapese have been satisfied with life under the Americans, recent movements against government plans for a jet airport and a reservoir system that would require the condemnation of Yapese land have caused many Yapese to question their lack of control of their own island. Still, there has been no general political education beyond occasional radio programs, usually in English, and political awareness remains low.

Micronesian leaders will have to contend not only with a politically undeveloped and disparate constituency but also with an American government reluctant to loosen its hold on an area of strategic military importance. With the loss of American military bases in Okinawa, Micronesia has become even more important to the United States, as indicated by Air Force plans to build a large base on Tinian and military demands for more than one-quarter of the land area of Palau.

Commenting on the breakdown of the status talks, the head of the U.S. delegation, Franklin Haydn Williams said that the United States will never give up the trusteeship "on ground which would in any way threaten the stability of the area and which would in the opinion of the United States endanger international peace and security." To the Micronesians who know what such phrases have meant in the past, this must sound ominous indeed. ☐

Seeds: The Carriers of Life

An Architect's Portfolio of Botanical Sketches



by Willard K. Martin

The first real seeds were naked—they had no hard protective coating like the seeds of today. But they were an evolutionary advance over spore-bearing plants because they no longer required water for the fertilization process. Instead, the female plant was pollinated by wind-borne male cells. Naked seeds produced the trees and shrubs of the first great coniferous forests of the dinosaur age—the ancestors of our redwoods and pines. Some of the naked-seed plants that evolved at that time are ginkgos, firs, spruces, and cycads.

It is difficult to determine with certainty how naked-seed plants evolved into modern plants with covered seeds. There must have been a gradual change, but no fossilized record shows the complete process. Eight hundred million years elapsed between the first ocean plants and the birth of flowers. A multitude of colors then invaded the greens of ferns, mosses, and dark, coniferous forests. With the flowers came seeds of all sizes, shapes, and colors—seeds with coatings, insulated from excessive heat, moisture, and cold. Through a complex development of fertilization and genetic change, the seed became a carrier of the tiny embryonic plant. It also insured initial growth of the young plant by storing nourishment in the form of oils, carbohydrates (starch and sugar), and protein. Furthermore, a variety of devices evolved for the dispersal of the seeds.

The ovary of the flower contains the structure for the developing seeds and systems for their protection, packaging, and distribution. The ovary takes many forms even within the same genus of plants; at maturity, it may develop into a fleshy or dry fruit. In simple cases, the mature fruit is a container that dries out and splits open along a given margin, spilling its seeds at random. In more complex systems, the specialized ovary develops wings, hooks, screws, explosive devices, or spring-loaded propellants. Some systems rely on animals, birds, and insects to carry their life-giving contents to another place, insuring seed distribution and offering a better chance for survival of the species. Other seed systems float, sail, spin, and parachute to their new resting places.

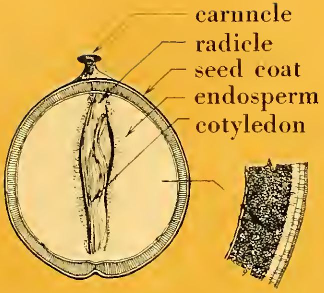
The seeds of common plants, such as the thistle, dandelion, and milkweed, have been dispersed through the air for millions of years on the same principle as the glider and the parachute. Winged fruits, known as samaras, range in size from the very small to the very large. They fall slowly, autogyrating in still air. But when picked up by strong winds, the flight distance of these fruits is greatly increased, resulting in broad dispersion of a species. The maple key is a typical example. Other, similar winged seeds are produced by the tulip tree, the tree of heaven, the common ash, and the Indian bean tree. Another variation of winged-seed systems is found in the highly specialized airfoil leaf of the basswood. In this plant, bundles of three or four seeds hang below the leaf wing on delicate stems, providing stability as the whole mechanism glides gracefully to earth.

Some fruits have become adapted to transportation by water. They are insulated, buoyant, and sufficiently waterproof to float great distances. The coconut, for example, consists of a hard nut, impervious to seawater, that is contained within a fibrous, air-filled husk. The whole assembly is ideally suited to its element of transport—the sea. Sea beans, as in certain *Entadas*, have an air cavity inside their hard shells making them buoyant for floating in water. These mechanisms for floating combined with their insulation against seawater have enabled the coconut and sea bean to be widely distributed in the tropical areas of the world.

The seed head of the lotus, a freshwater plant, floats top down in the water, carried along by wind and currents. In this position, the seeds, which are heavier than water, fall out and drop to the bottom where they eventually germinate.

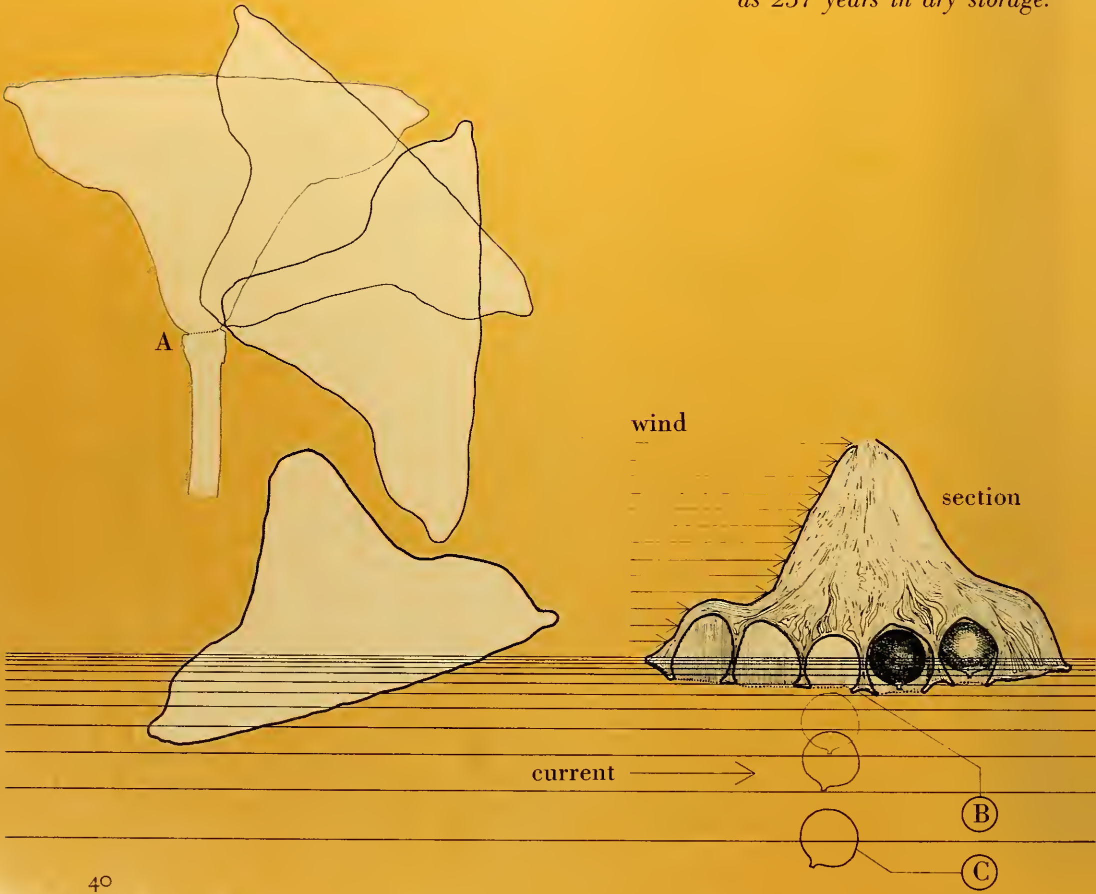
The wild geranium has a seed pod system that consists of a central axis surrounded by five carpels, each of which is connected to the axis by a flexible springlike structure. When the carpels are mature, the dried out spring connections snap the seed containers sharply upward, catapulting the seeds for some distance. Wood sorrel, spurge, violets, and witch hazel are other plants that have similar explosive systems for seed ejection. Incorporating a variation of these seed ejection systems, the squirting cucumber, which grows in the wet forests of central and eastern Mediterranean regions, produces a hairy, cucumberlike fruit. As the fruit ripens, pressure—probably caused by gas generated by heat and decay—builds up inside it. When the pressure becomes great enough, the fruit explodes, shooting the hard seeds as far as twenty-five feet through the air.

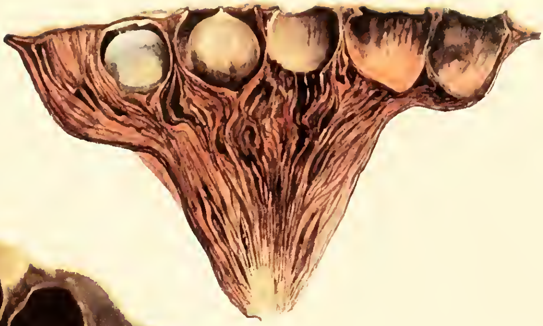
At least 200,000 species of flowering plants are known in the world today. Each has its own unique structure and seed system, modified and refined over millions of years to insure survival in its particular environment. The following portfolio of sketches shows some of these engines of nature, which are the very promise of life. □

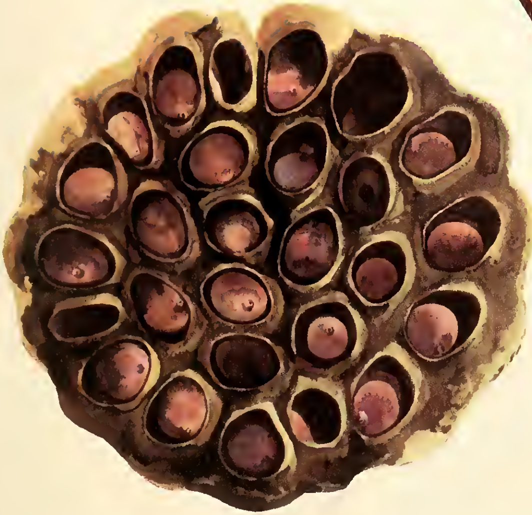


seed section

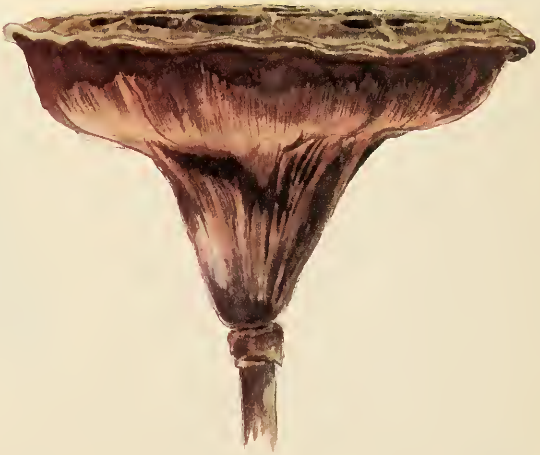
When the nutlike fruits of the lotus become ripe in their individual pockets, the whole seed head breaks from the stem (A) *and falls into the water where it floats face down. Even if the head is righted, it will automatically turn upside down again. Owing to its fibrous interior and many air spaces, the lightweight head floats easily and is readily transported by wind and currents. While the lotus head is face down in the water, the rims around each seed pocket* (B) *gradually decay and the nonbuoyant seeds* (C) *drop out and sink to the bottom of the watery environment where they germinate. Lotus seeds are believed to remain dormant longer than any other seeds known; some are reported to have sprouted after as much as 237 years in dry storage.*



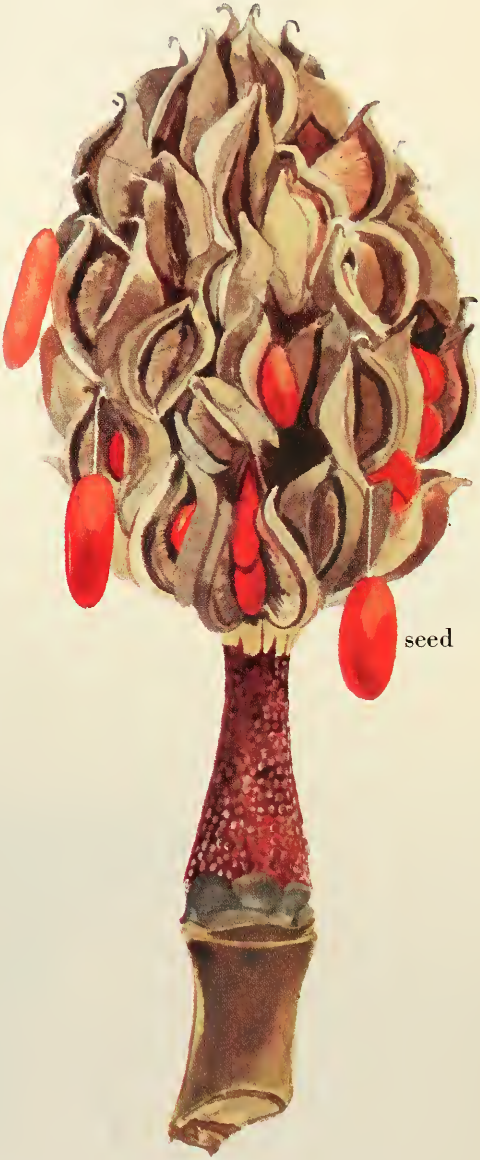




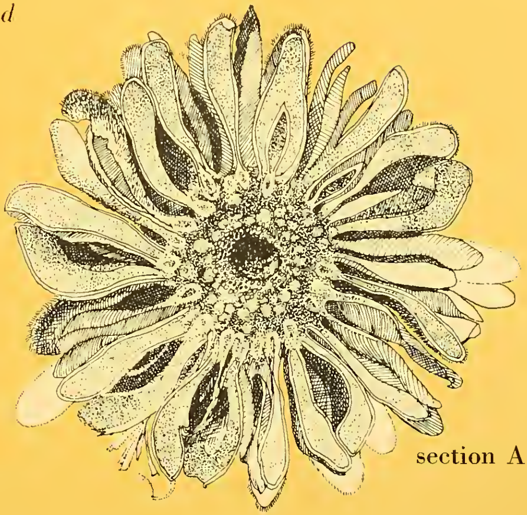
Lotus, Nelumbo nucifera



Southern magnolia, Magnolia grandiflora


section A
seed

The magnolia is one of the most ancient of flowering trees. Its scarlet-coated seeds, which dangle from its conelike fruit on fine white threads, are a source of food for birds. The seeds pass unharmed through the animals' digestive tracts and are transported by the birds to new locations where they are dropped to the ground in excreta.



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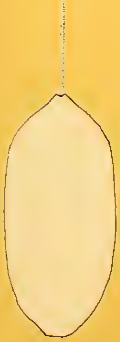
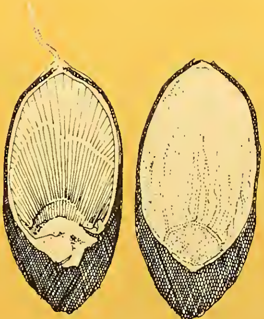
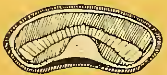


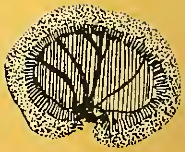


vertical seed sections

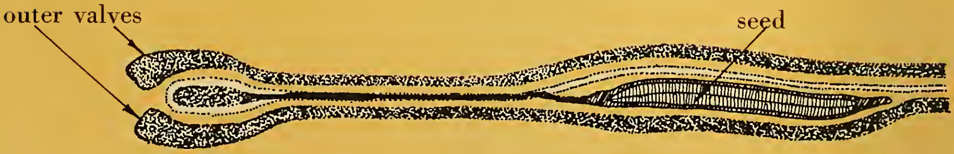


cross section

The seeds of this plant are contained within two outer walls, or valves, that make up the flat fruit. At maturity, the valves split apart and fall away. The flattened seeds then drop out.

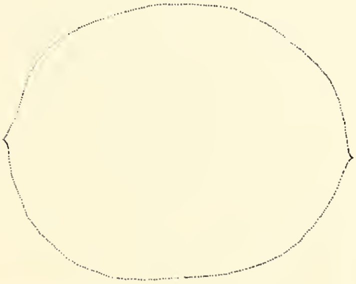


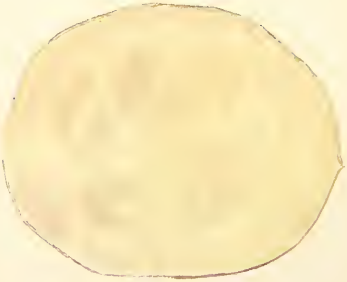
single seed

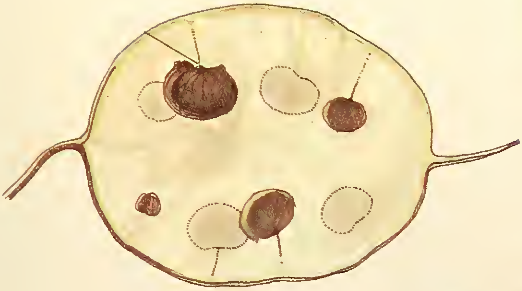


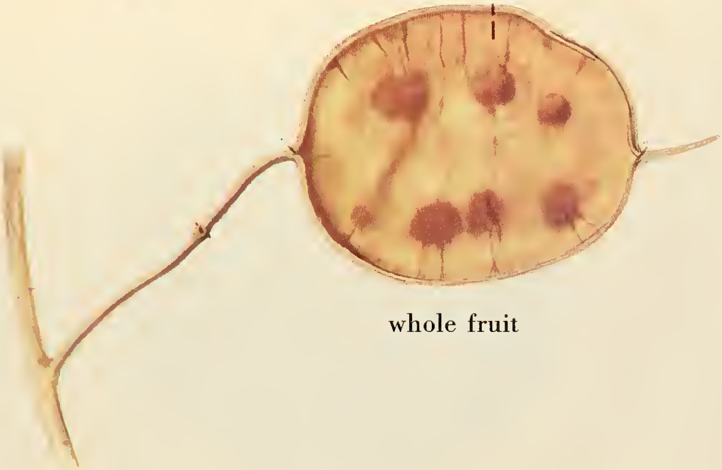
partial section through fruit

Honesty plant, *Lunaria annua*



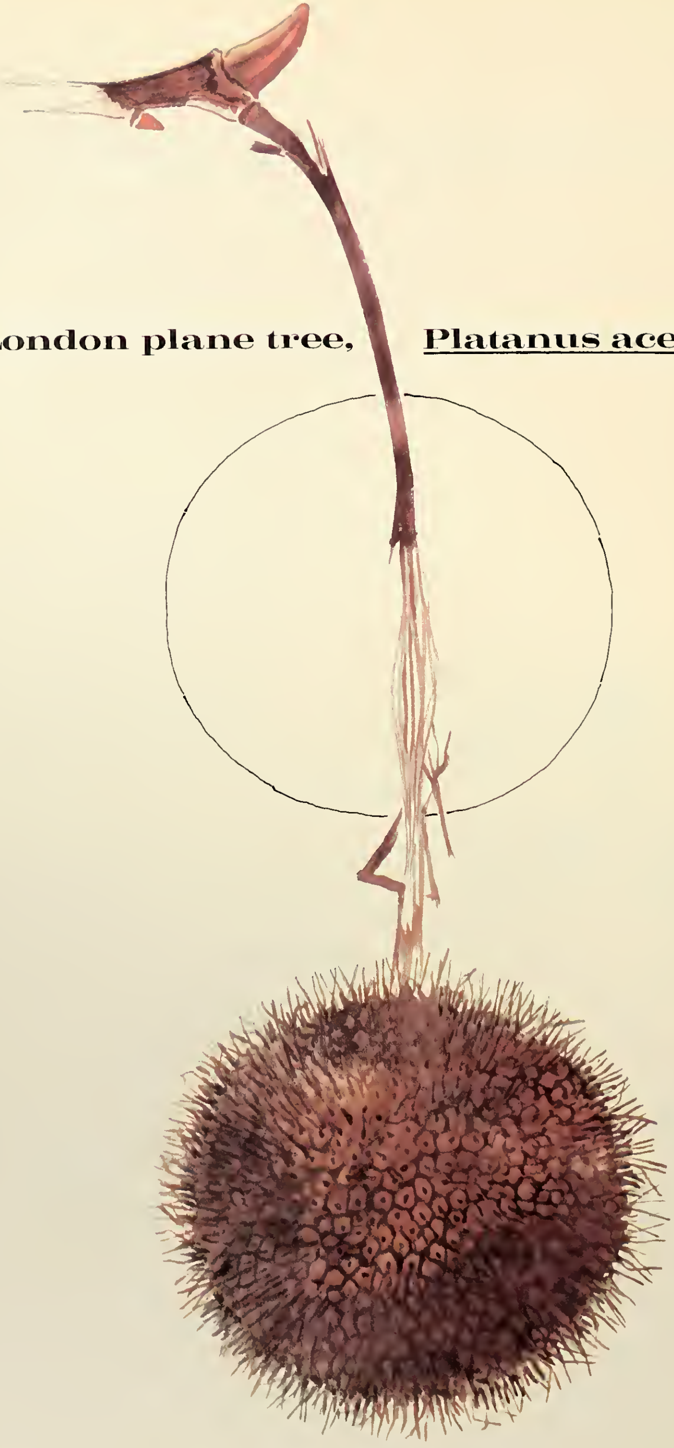


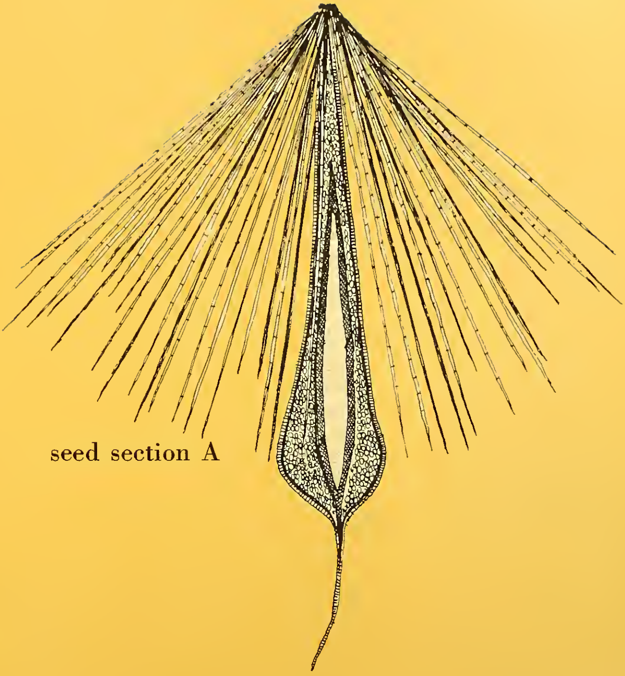




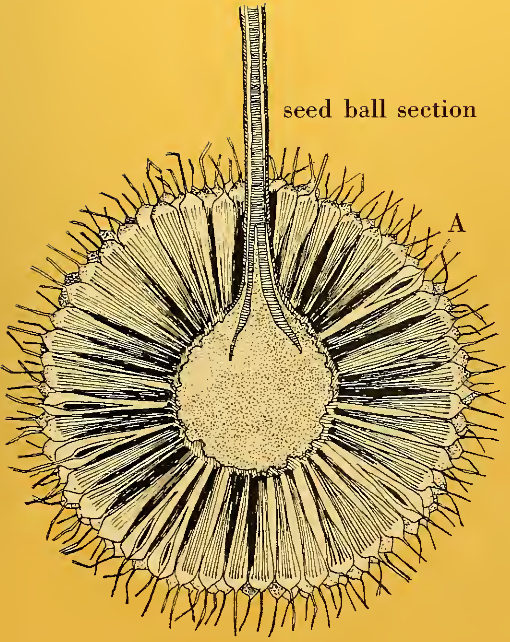
whole fruit

London plane tree, Platanus acerifolia





seed section A

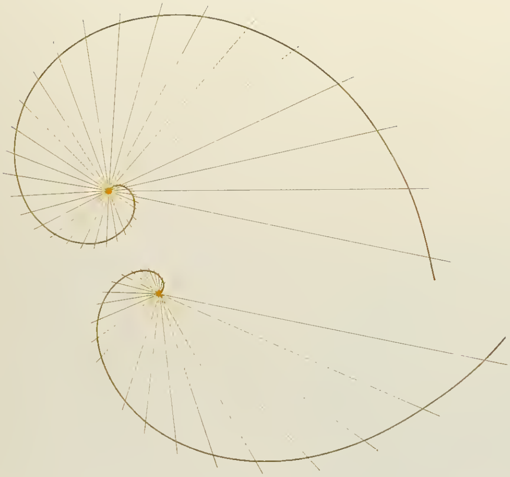


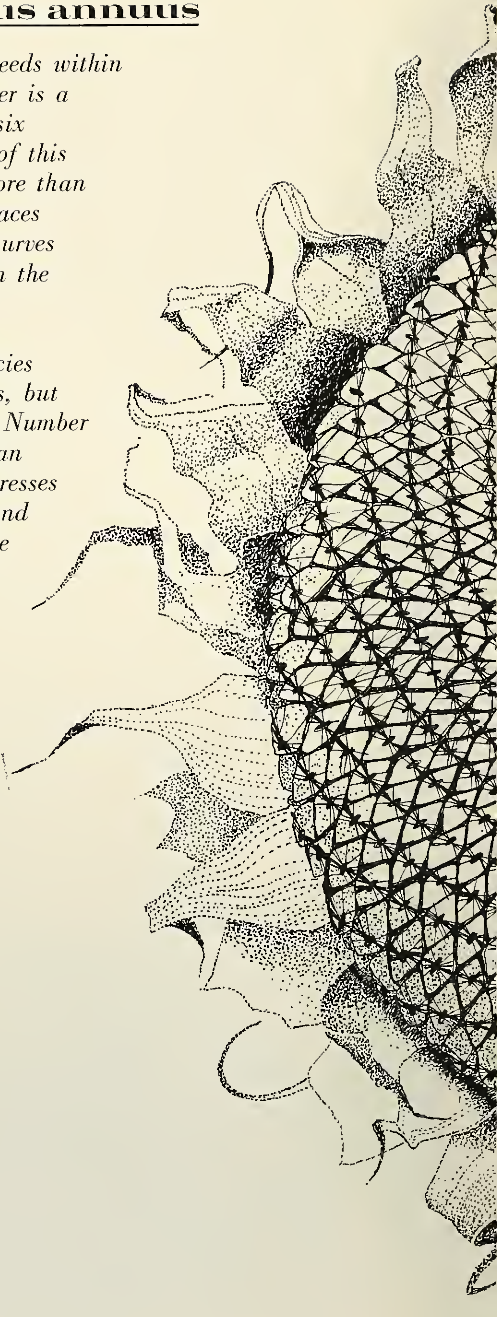
seed ball section

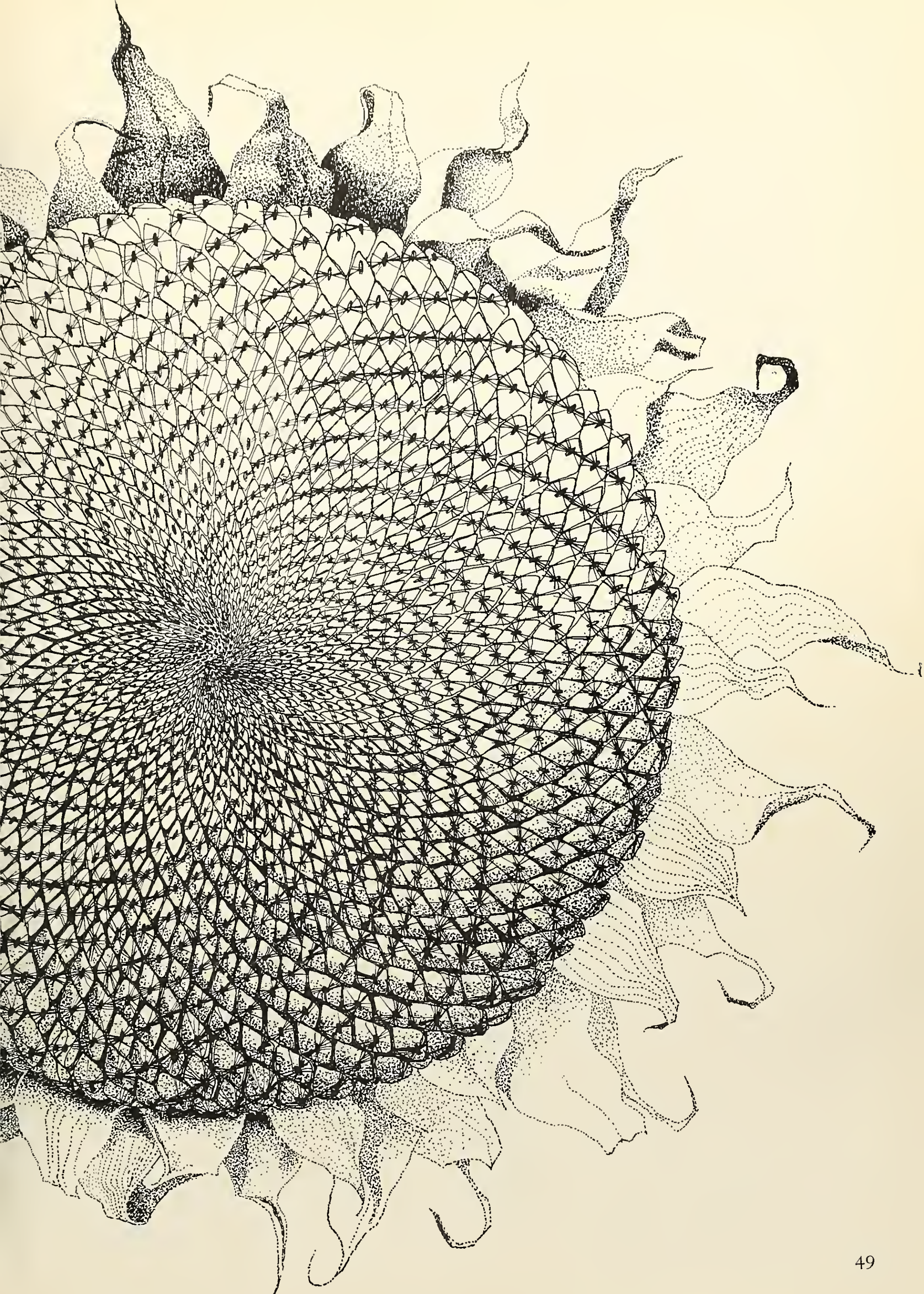
The London plane tree is a hybrid of two kinds of Platanus. *It usually bears two seed balls, one directly above the other, on a single stem. Each ball consists of innumerable small fruits, surrounded by tightly packed bundles of hollow, lightweight hairs. When the hairs dry at maturity, they open out like the ribs of an umbrella, thereby disconnecting the fruits from the cores that held them. Supported in the air by the hairs, the fruit is free to be carried away by the wind.*

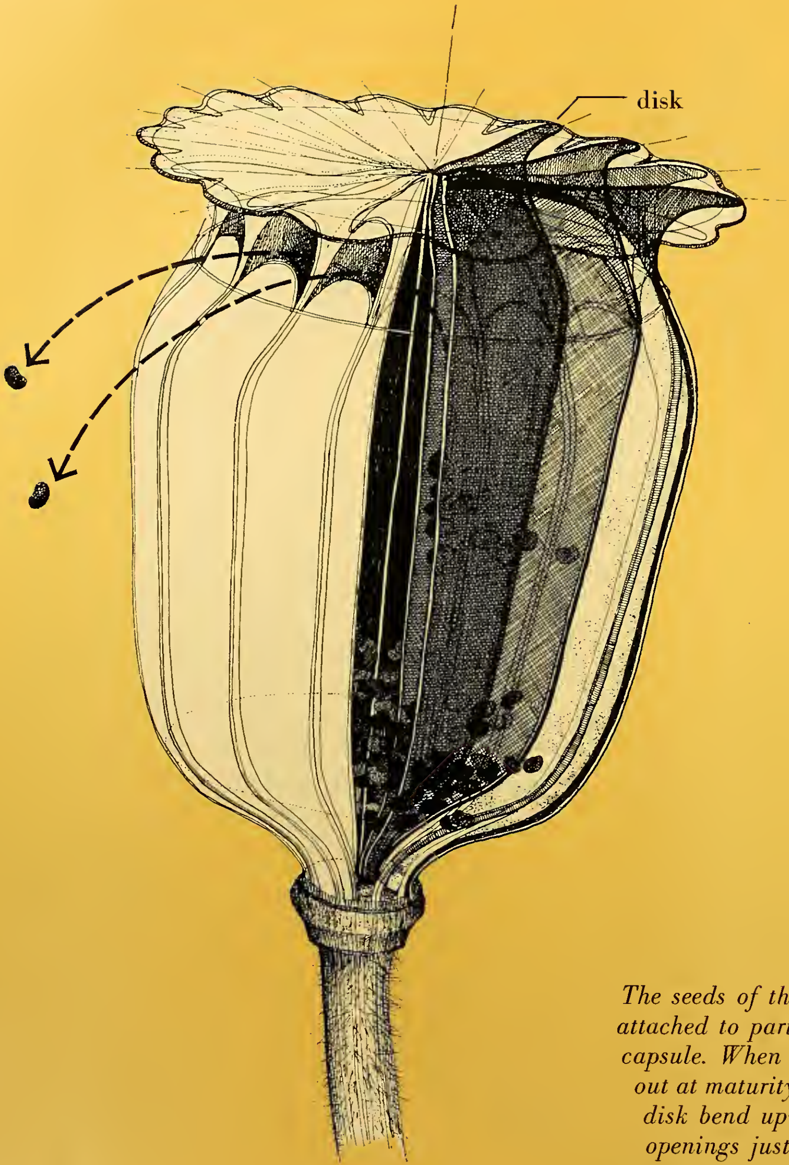
Giant sunflower, Helianthus annuus

As a system for packaging a great number of seeds within a compact space, the head of the giant sunflower is a marvel of precision and efficiency. From about six inches to a foot or more in diameter, the head of this plant of the Compositae family may contain more than a thousand seeds. They are arranged within spaces formed by the intersection of two sets of helix curves (see below), one of which rotates clockwise from the center of the head, the other counterclockwise. This sunflower contains thirty-four clockwise and fifty-five counterclockwise curves. Other species may have other quantities of intersecting helices, but their numbers always conform to the Fibonacci Number System, named for the late-twelfth-century Italian mathematician who devised it. The system progresses as follows: 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, and so forth. There is a high correlation between the morphology of most complex plants and the Fibonacci System, although the significance of that phenomenon —if any—is not understood.



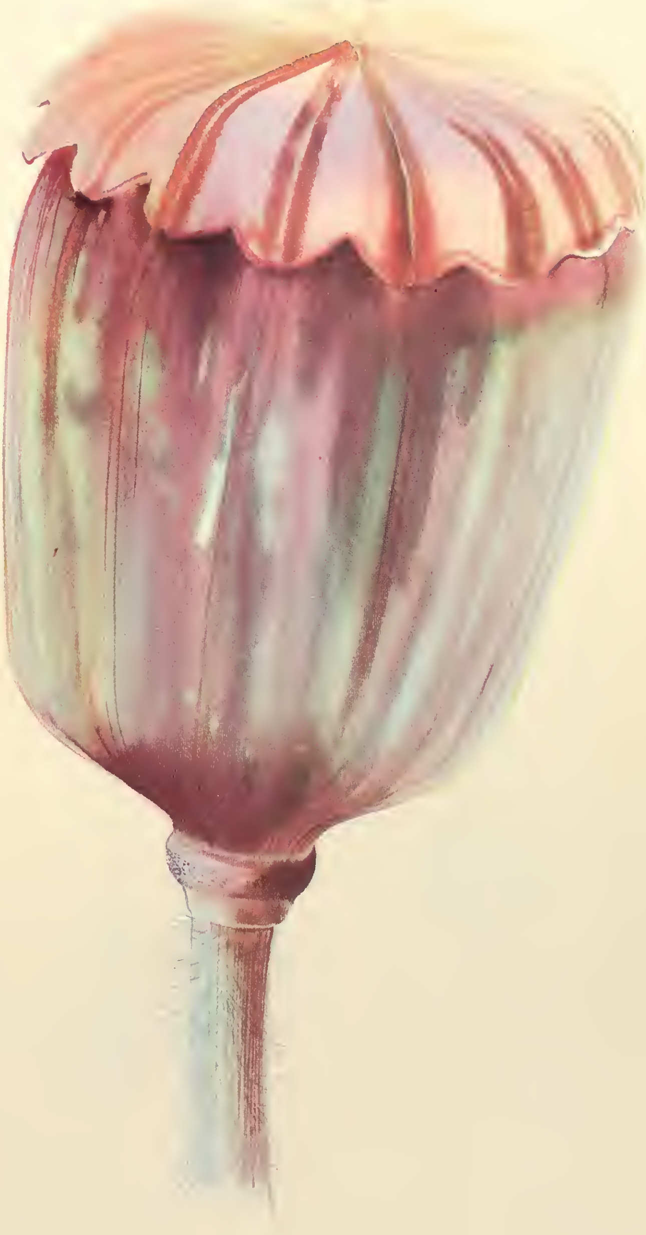




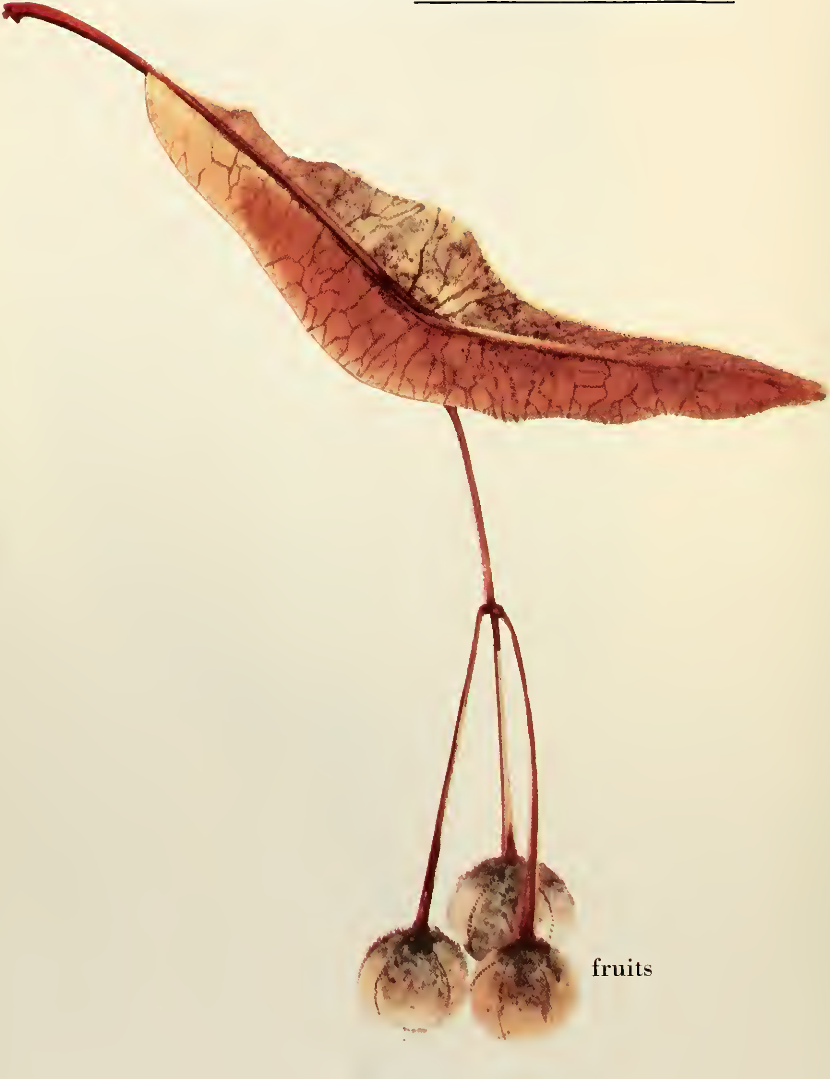


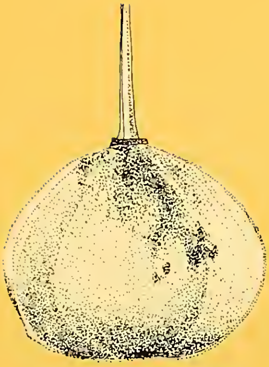
The seeds of the corn poppy are attached to partitions within the capsule. When the capsule dries out at maturity, the edges of the disk bend upward, uncovering openings just below it. At the same time, the seeds break free. As the stem waves back and forth and the whole plant is bent by the wind or passing animals, the seeds shake around within the capsule and are thrown out of the openings.

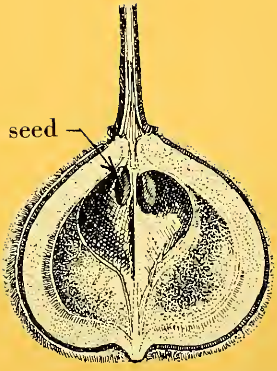
Corn poppy, Papaver rhoeas



Linden tree, Tilia americana

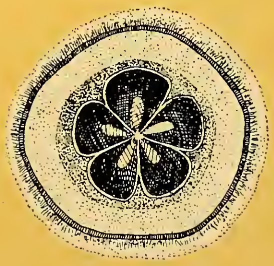






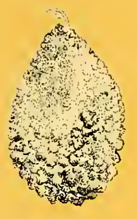
vertical section

The seed apparatus of the linden tree consists of a sail leaf, or bract, and clusters of attached, pea-sized fruits. The sail transports the fruits in a spiral motion to the ground where the woody capsule containing them decays very slowly, thus delaying germination for several years.

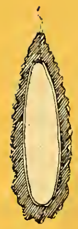


horizontal section

The well-insulated and extremely durable capsule of the unicorn plant contains seeds stacked in two layers in an alternating pattern. When the capsule matures, it dries out, becomes brittle, and splits apart. The seeds then fall out.



seed



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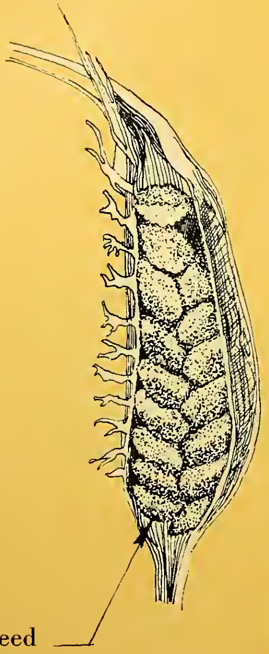
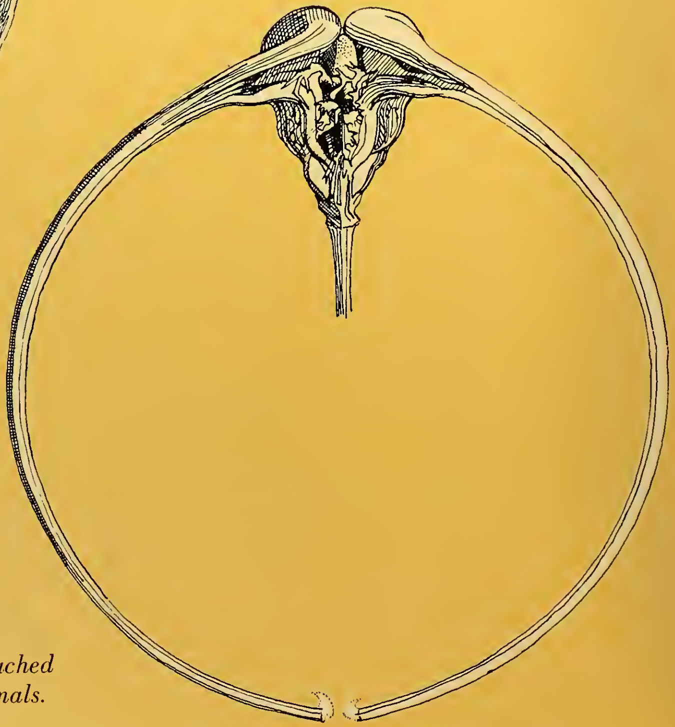
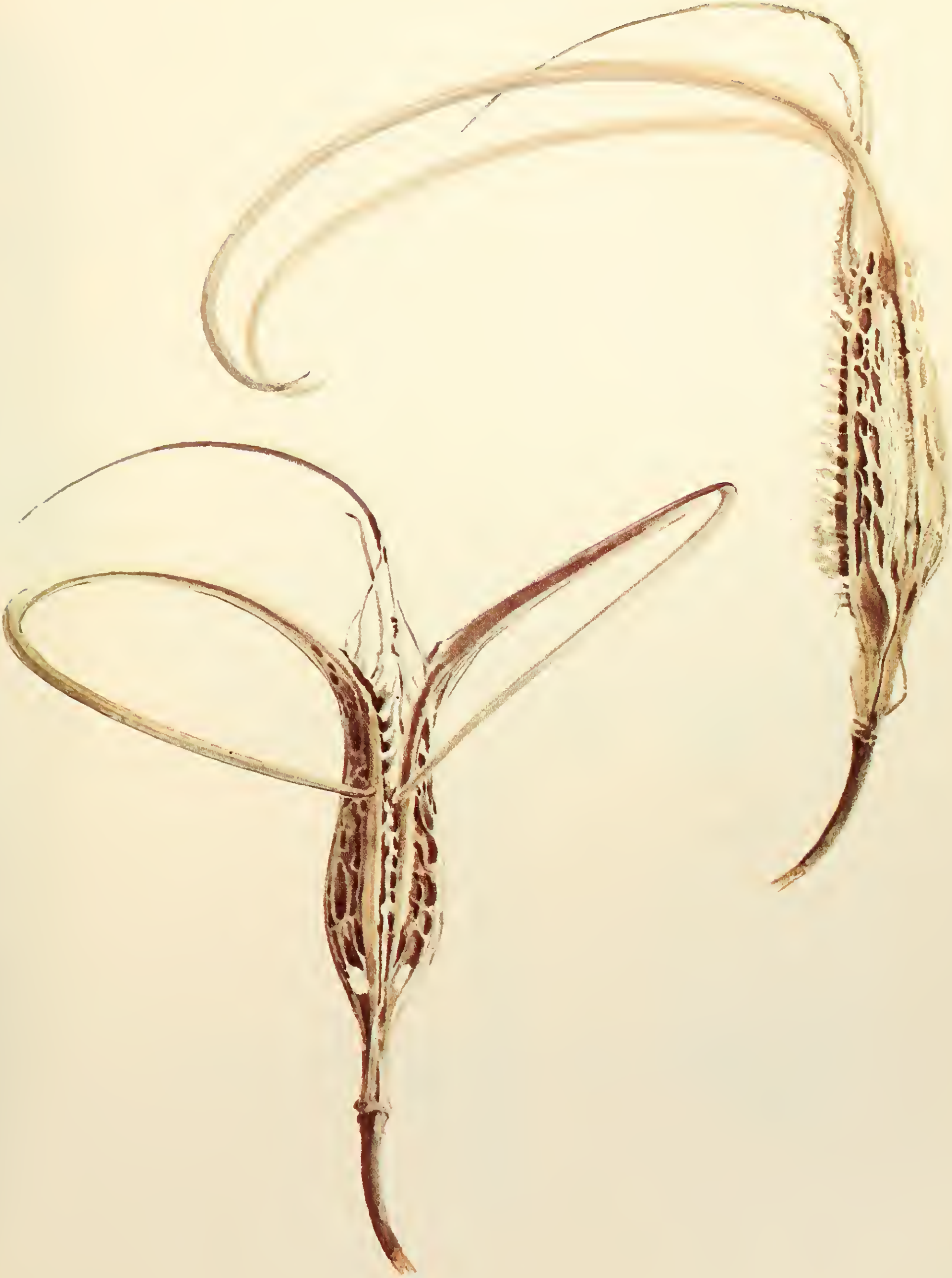
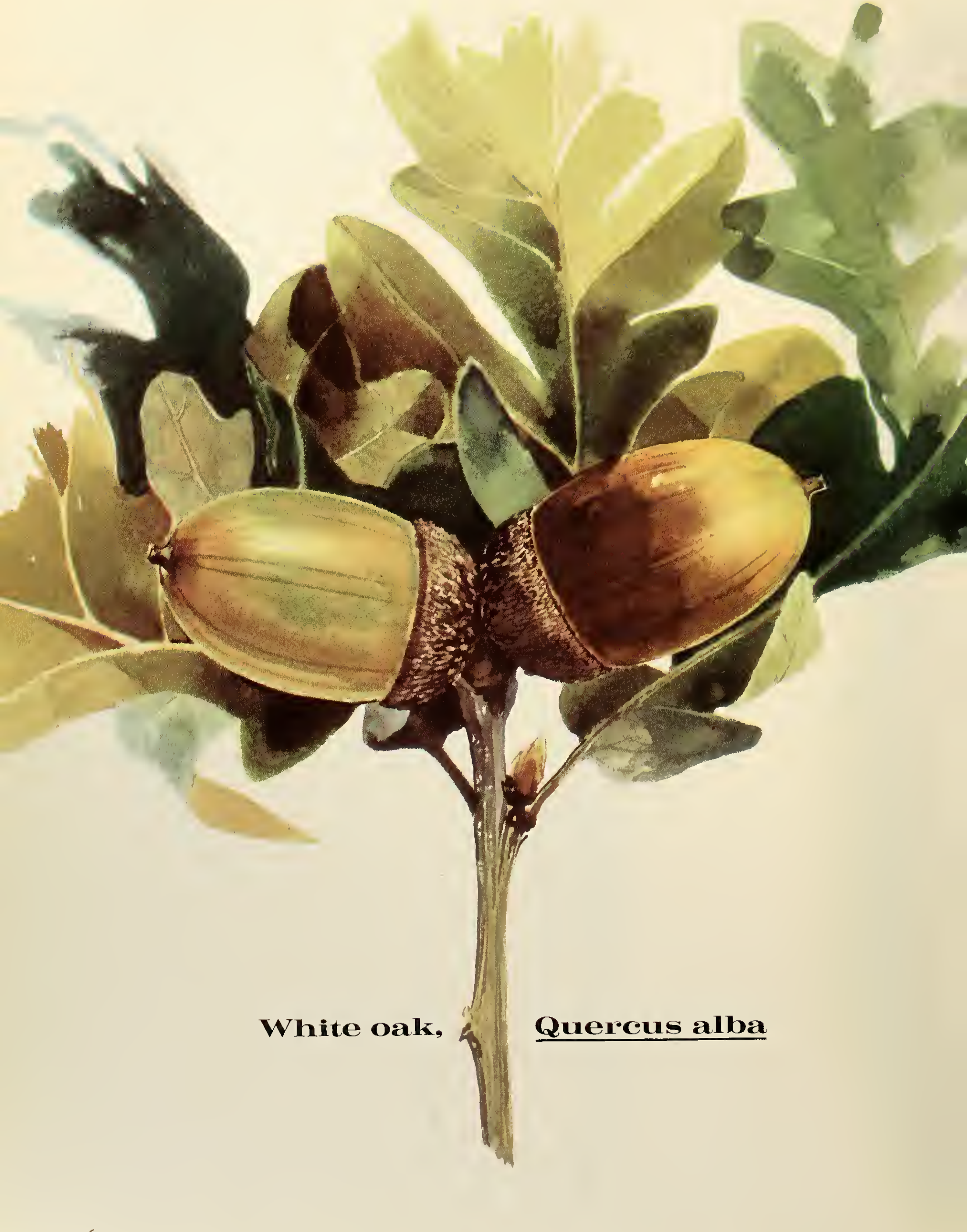




The plant's large, horned beaks may also play a part in seed dispersal by becoming attached to the fur of roaming animals.

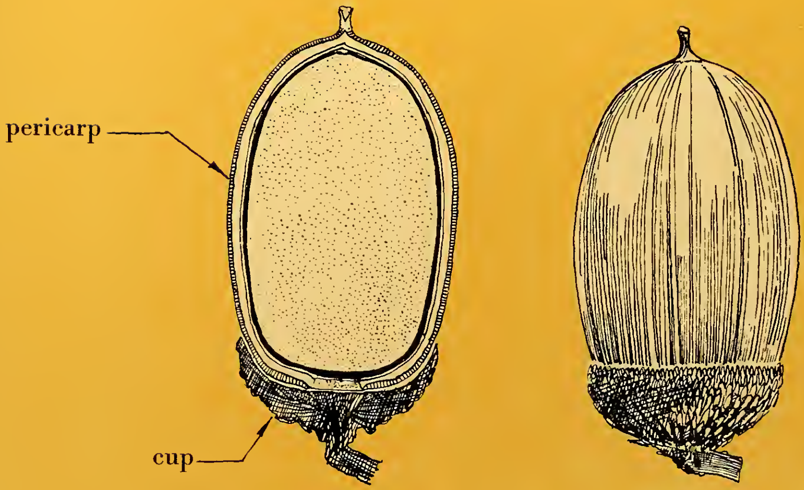
Unicorn plant, Proboscidea louisianica





White oak, **Quercus alba**

Found commonly along the east coast, the white oak requires approximately fifty years to mature and bear acorns. When the acorns are ripe, special cells below the nut separate, allowing it to disengage from the cup. Typically a hard-shelled, one-seeded dry fruit, which remains closed at maturity, the acorn is a source of food for many birds and animals.



section of nut

The Architecture of Seed Systems

To a botanist, a seed system is part of a plant's morphology, no more noteworthy than its roots, stems, and leaves. But for an architect studying plant life and reproduction as a pleasurable pastime, seed structures and systems have a special significance. Much of contemporary architectural design bears a striking resemblance to them.

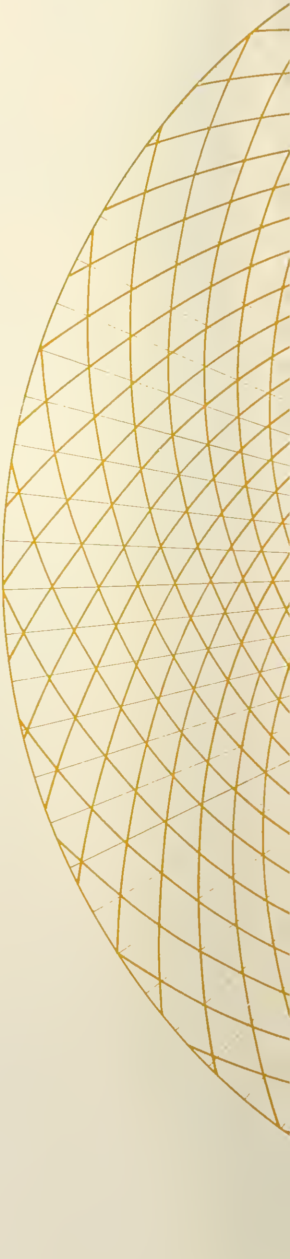
The domed, steel-reinforced concrete structure designed by Italy's famous architect Pier Luigi Nervi to house the Olympic Games held in Rome in 1960 is based on the same structural system of intersecting helix curves as the giant sunflower. So was the domed roof structure he engineered in 1942 for a hall and baths at Chianciano, Italy. The sole difference is that Nervi used an equal number of clockwise and counterclockwise curves in his structures, whereas the sunflower has an unequal number.

Another instance of art echoing nature is the geodesic dome designed by Buckminster Fuller, the American architect-inventor-philosopher. Fuller has long been concerned with the problem of enclosing space with a minimum of weight and a maximum of strength. His geodesic domes, which are versatile, light, and strong, have the organic character of a *Volvox* colony and often suggest the crystalline quality of certain diatoms or the membranous envelope of the Japanese lantern plant.

Finally, something of the structure of the corn poppy capsule can be said to be mirrored in the design philosophy of Louis I. Kahn, a contemporary American architect who was the first proponent of integrated architectural systems. It is Kahn's belief that since all the elements contained in the design of a building (such as structure, heating, cooling, ventilation, lighting, and vertical transportation) are interdependent, they should be reflected not only in the function of the building but also in its final visual form. The fresh architectural shape of the Richards Medical Research Center, his first significant work, built more than a decade ago for the University of Pennsylvania in Philadelphia, is a testament to the validity of his approach.

Looking at the corn poppy capsule with the eyes of an architect, one can see the plant's disk as a cantilevered, folded-plate roof supported by compound beams that rest on columns connected to the capsule's outer wall or pericarp. The columns not only support the roof, but also carry nourishment to the seeds inside, much as the visible vertical elements in Kahn's buildings contain pipes, wiring, and elevators.

Nature provides us with an inexhaustible source of clues for the efficient design of man-made structures. A study of the clues inherent in the extensive variety of seed systems might thus provide the inspiration for anything from a simple tool to a complex urban plan. ☐



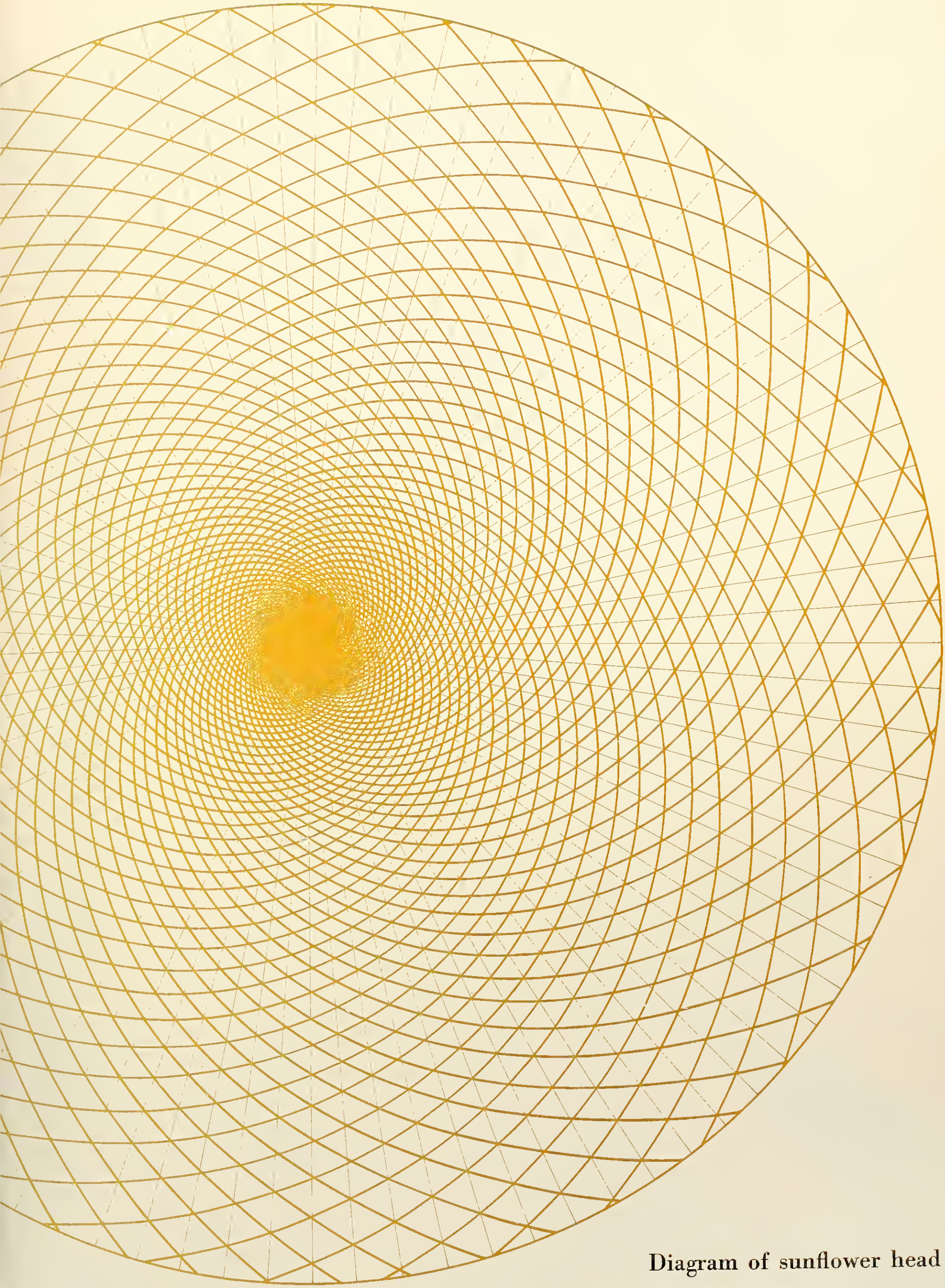


Diagram of sunflower head

So Fair and Foul a Bird

The elegant, crested hoopoe, known since Paleolithic times, has evolved some repellent tactics for survival

by Charles Vaurie

photographs by Hans Silvester

RAPHO GUILLUMETTE PICTURES

A strikingly beautiful, crested bird of the Old World, the hoopoe's first graphic representation was as an image carved into rocks during Paleolithic times. The bird's association with classical lands is recorded in the folklore, literature, and art of the ancient world; it was pictured on the walls of ancient tombs and temples in Egypt and Crete, listed among the "unclean" birds proscribed in Leviticus and Deuteronomy, and featured by Aristophanes in his fifth-century B.C. political satire *The Birds*. The hoopoe probably originated in the Mediterranean region, but as its range expanded, it began to appear in the lore of other regions.

The hoopoe is a most elegant bird, with bold plumage and a large, mobile crest. The bird is about eleven inches long, including its crest but not its long, slender, and slightly decurved bill, which varies from two to two and a half inches in length. The upper part of its body is subtly colored, varying from pale pinkish brown on the crest to vinaceous or cinnamon on the rest of the head, neck, breast, and upper back.

In contrast, the lower back is broadly banded with black and cream, and the wings and tail are glossy black with bold bars of pure white. The broad feathers of the crown are conspicuously tipped with black, and a subterminal white bar on the feathers of the center and hind part of the crest emphasizes these black tips.

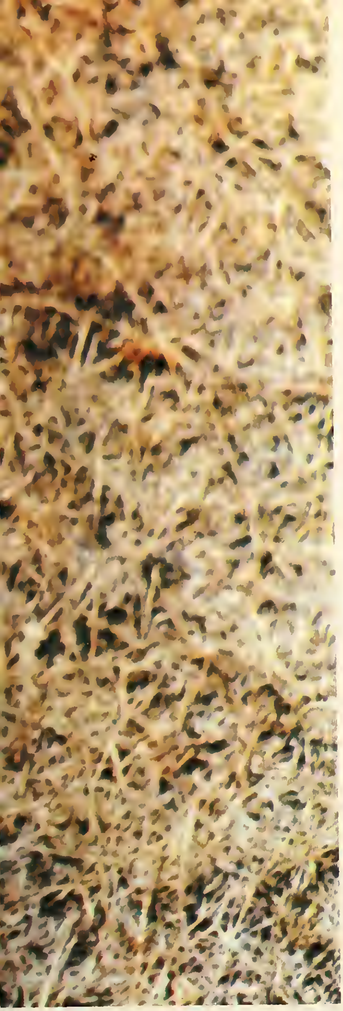
It is the hoopoe's crest that has attracted most attention and led to some of its appellations. The Turks, for example, call it the messenger bird because its crest resembles that formerly worn by couriers. The crest, normally depressed in flight or when the bird is feeding or tending its young, breaks into a great fan during courtship display and when the bird is concerned.

The hoopoe's wings are rounded, and its flight is exceptionally buoyant but irregular. Dipping, undulating, or swerving abruptly from side to side as it flies not far above the ground, the boldly banded bird resembles a huge butterfly.

Its flight is not as weak and erratic as it appears, however, for observers have noted that the bird can readily break away from falcons, mounting easily into the air to escape.

The hoopoe's vast distribution is surpassed by few other land birds. From its home in the Mediterranean, it has spread north in Europe and Asia to about 60° north latitude and eastward across Eurasia to the Pacific coast, ranging south into India, Ceylon, the Malay Peninsula, and Sumatra. The hoopoe also occurs throughout Madagascar and Africa, with the exception of the

The hoopoe characteristically flies not far above the ground; its rounded wings and bold plumage give it the appearance of a huge butterfly. In flight, it dips, weaves, or swerves abruptly from side to side—but the bird can also mount easily into the air to escape birds of prey. Originally a bird of the Mediterranean region, the hoopoe can now be found in meadows, orchards, and groves throughout the arid and semiarid parts of the Old World. During the winter months, it migrates to warm climates.



Nesting directly on the bottom of a cavity, usually with no material added to the site, hoopoes raise four to six young. During this period, the brooding female and the offspring produce a foul secretion to repel predators. The open crest of the parent, left, is not typical of a hoopoe feeding its young; this individual was probably concerned about the photographer's presence.

Hoopoes are typically ground feeders, using their long, slightly decurved bills to seize insects, worms, spiders, or other animal matter.

equatorial forest and the heart of the Sahara.

Although the hoopoe's range has expanded, it betrays its Mediterranean origin by returning to sunny regions for the winter and by avoiding heavily forested or humid areas. The winter quarters of the Eurasian populations are in Africa, peninsular India, and farther east, the region south of the Yangtze River.

The main requirement of the hoopoe is a warm climate in flat or hilly, but not mountainous, country. It is a bird of open, predominantly arid or semiarid areas, although its habitat does vary. Hoopoes can be found in vineyards, orchards, gardens, olive groves, pastures, wooded steppes, meadows bordered with old trees, or in fact, any parkland.

Hoopoes nest in cavities, using knotholes and woodpecker excavations. But the bird is not dependent on trees, and if not molested, will frequent human habitations, nesting in holes and crevices in old stone walls, ruins, or any large pile of loose stones. It will even nest inside houses or in nesting boxes.

The hoopoe does not build a nest in the usual sense. Normally no nesting material is provided; the bird lays and incubates its eggs directly on the bottom of a cavity. The hoopoe is reputed to be a filthy housekeeper, and even scientific accounts claim that it does not clean food debris or excrement from its nest. This reputation is not deserved, according to the Swiss ornithologist Paul Géroudet. He reports that the hoopoe cleans its nest regularly, but that as the young grow bigger, sanitation becomes difficult in the narrow cavity and may be abandoned altogether.

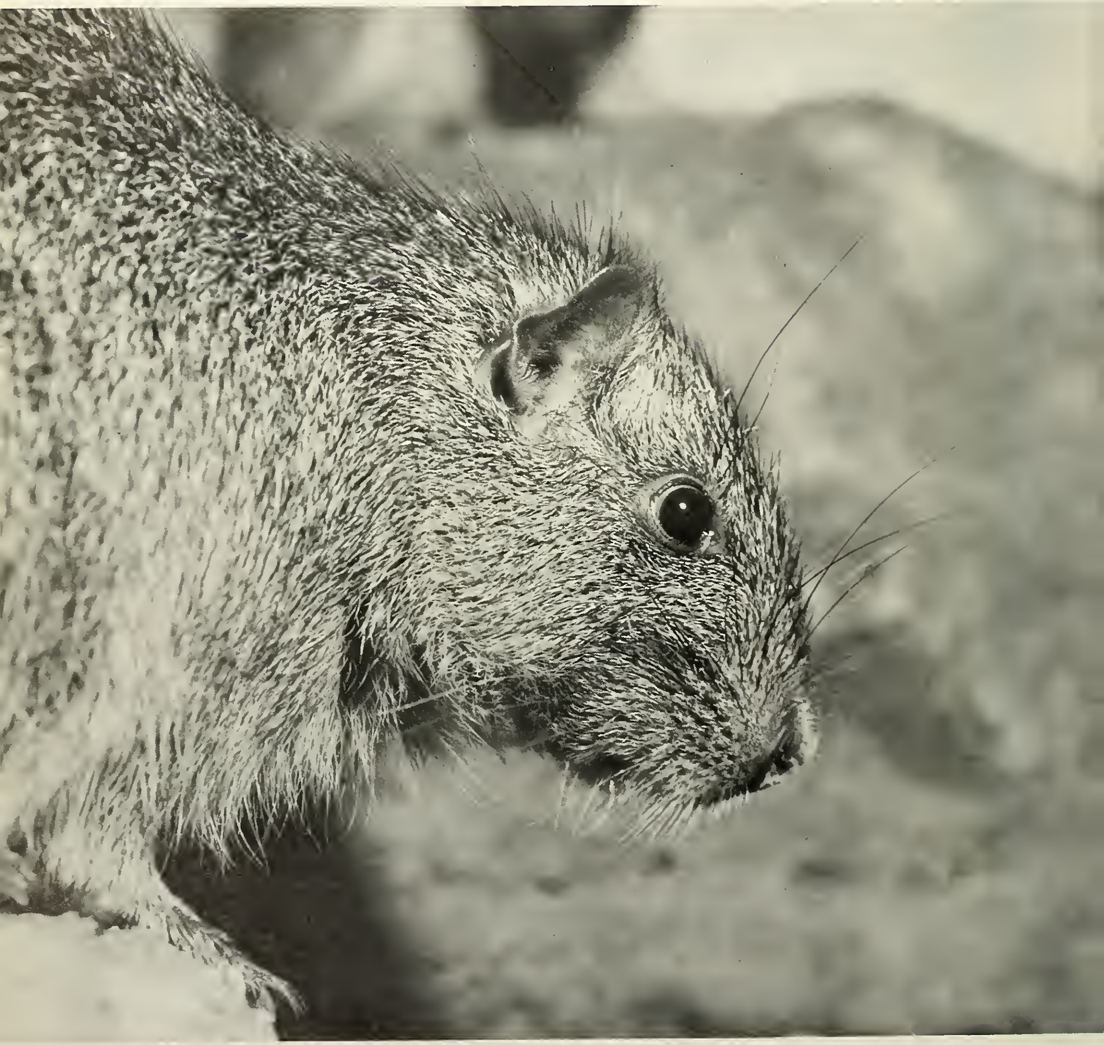
The reputation of the "stinking" hoopoe, however, is deserved. The incubating and brooding female and the young, until they are about a month old, produce a brownish secretion that can be projected at will from the anal gland. Its nauseating smell has been compared to that of putrefying flesh mixed with the urine or other strong secretions used by felines when marking territory. In addition, when disturbed, the young ejaculate liquid excrement over a distance, snap their bills, and hiss loudly and long.

Interestingly, the male does not produce these secretions. He also does not share in the incubation and care of the young, although he does feed the female during this period. Presumably, these highly unpleasant odors repel predators—certainly, they discourage human intruders—but only during a short, critical period of the hoopoe's life and breeding cycle.

The origin of the hoopoe's name has also been misunderstood. For a long time it was believed that the bird's French name, *huppe*, meaning "crest," called attention to the bird's prominent crown. More likely, the name is onomatopoeic, an imitation of the male's call during courtship and breeding that can be expressed as "hoop-hoop-hoop." A low, soft call that seems muted when heard close up, it actually has great carrying power.

To anyone who has watched the hoopoe unfold its bright, tawny crest in the form of a sunburst, it is easy to understand why the bird has long been associated with the sun and the renewal of the earth. To the ancient Greeks and other worshipers of the Great Mother Goddess, her lover, the sun, appeared to her each spring in the form of a hoopoe. Today, this colorful bird—migrating with the sun, fluttering like a butterfly in orchards and groves—is a vibrant reminder of the moving poesy of the old myths. ☐

A Most Peaceable Rodent



WILLIAM MENG, NEW YORK ZOOLOGICAL SOCIETY

A socially tolerant population of hutias thrives on the limited resources of a small island

by Garrett C. Clough

A relict population of a rare and obscure mammal, the Bahamian hutia, has been found thriving on East Plana Cay, a small, uninhabited island at the southeastern end of the Bahamian archipelago.

The general name hutia applies to a number of related species of Caribbean rodents whose closest well-known relative is the nutria, the popular fur bearer from Central and South America. All were once plentiful and widely distributed throughout the Greater Antilles. Of the six recognized genera, however, only three remain; the other three are extinct. The surviving species are all suffering severely from progressive alterations of their island habitats. The Bahamian hutia, *Geocapromys ingrahami*, together with the other seven species of this failing family, the Capromyrdae, has been included on the list of the world's rare and endangered mammals by the International Union for the Conservation of Nature and Natural Resources.

The origins and early history of the Bahamian hutia are uncertain. Today different species of the same genus occupy Jamaica and distant Little Swan Island off the coast of Honduras; they once lived on many other islands in the Bahamas as well, some until early in this century. Hutias served as food for early Indian settlers and may have been carried along on their voyages as a semidomesticated source of food. Their bones have been unearthed from kitchen middens of the pre-Columbian inhabitants of the Bahamas. Predation by dogs, increased consumption by humans, and destruction of their habitats probably led to their almost complete disappearance.

A number of wild hutias were attracted by the squeaks of captives under observation. The calls may have been distress signals.

Basing their action on a report by members of The American Museum of Natural History's Lerner Marine Laboratory on Bimini that hutias still survived on East Plana Cay, the Bahama Ministry of Agriculture and Fisheries had instituted a strict policy of absolute protection for these animals, even to regulating visits to East Plana Cay. In March, 1966, I received permission to visit the island and study the hutias' environment and ecology and estimate their numbers. My permit prohibited the removal of any specimens, living or dead, and further specified that my investigative methods would not harm the hutias.

East Plana Cay, five miles long and a quarter-mile wide, is a curved strip of land approximately 170 miles north of Cuba's eastern tip. A sparse grove of palm trees punctuates the western end, but the rest of the landscape is low scrub and barren rock surface. It is not at all the luxuriant semitropical paradise that I had envisioned. In fact, the tiny island looks particularly barren and inhospitable.

A long, sloping beach leads to a flat sand terrace covered with trailing ragweed, and a few sprawling clumps of low buttonwood trees provide the only shade and shelter for a campsite. The rest of the island's surface is made up of slabs and chunks of jagged, weathered limestone formed by coral growth. Large, thin plates of rock clanked with hollow metallic sounds when I walked over them. Open cracks and fissures in some places lead down into empty chambers, some large enough for a person to crawl into. In other places a solid pavement devoid of vegetation gives the appearance of a miniature moonscape with sharp, rocky towers and eroded hollows. From a high point on a rounded hill, about sixty feet above sea level, I could see that most of the central part of the island is covered with an even layer of woody shrubs. These species have small, succulent, needle-shaped leaves characteristic of desert plants. The island is, in fact, a semidesert with scrub thickets of the type described by botanists as growing on the driest and most impoverished sites in the Caribbean region.

My first afternoon on the island was hot and bright—the temperature reached nearly 90 degrees. I did not see a single hutia during an exploratory walk of a few hours. But the half-inch fecal pellets of hutias were everywhere—on the beach and sand terrace, on patches of soil, and on the bare rock. Obviously there were plenty of animals somewhere. But except for a few birds and numerous curly-tailed lizards, I seemed to be alone on the island.

The solitude didn't last long. At six o'clock the sun slid rapidly out of sight. Half an hour later only a few red tinges colored the dark evening sky, and then the first hutia appeared, walking toward me along the beach terrace. Within twenty minutes the ground was alive with the dark rodents. Seated at my camp I could see seven to ten hutias at a time, each one ambling along. The animals were clearly nocturnal. An hour after sunset the temperature had fallen to 75 degrees, and the humidity had risen. Nocturnal activity makes sense for warm-blooded mammals living in hot, dry habitats.

The animals moved slowly, heads slightly down and the rear of their bodies swaying as they waddled along. When motionless they assumed the shape of a lump, small ears hidden in fur, almost no neck or tail. When alarmed by my presence, however, they could run away nearly as fast as I could. They always headed for cover under the nearest rock or down the closest crevice, clambering along the steep, rocky escarpments with ease. They never threatened attack when alarmed or followed.

Eating occupied most of the animals' time at night. They nibbled and chewed at the leaves of shrubbery, gnawed at the bark, and snipped off the smaller twigs, eating them whole. Some individuals stretched up on their hind legs to pull branches to their mouths. The animals are adept at grasping and manipulating food objects with their forepaws. Frequently an agile hutia climbed into a shrub to get closer to the leaves growing at the branch tips.

The hutias were so abundant that they frequently encountered one another, but almost all of their activity was conducted independently. The most common social contact was when one animal approached another and sniffed at it or nudged it gently with its nose; the other animal invariably just waddled away. A few times I saw one hutia run from another in close pursuit and heard a few loud, short squeaks. On only one occasion did I see a chase end in a fight. The first animal was overtaken and he rolled to the ground with the pursuer on top of him. This scuffle lasted a few seconds before the first animal recovered his feet and ran off. In spite of the dense numbers of individuals, the hutias displayed a min-

Using its dexterous forepaws, the Bahamian hutia feeds on the leaves and twigs of a variety of shrubs.

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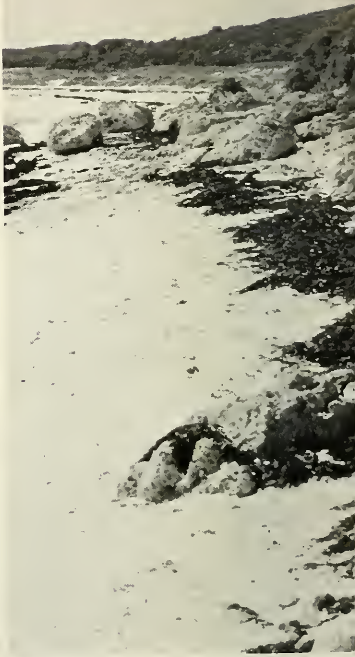


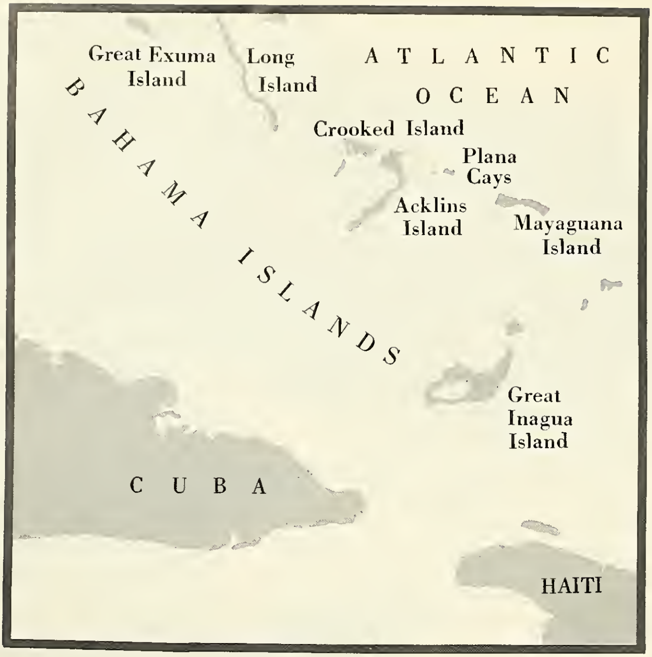
GARRETT C. CLOUGH

imum of aggression and hostility.

The hutias seemed to disappear as suddenly as they had become active. As the first light appeared in the eastern sky they began to withdraw into the rocks; half an hour before sunrise no more were to be seen. They were spending the days underground, using the natural openings in the surface of the island to enter the hollow inner regions. Where I could crawl below I found hutia tracks, but only a few fecal pellets. Tunnel openings and passageways led farther into the limestone. For the hutias, the honeycombed island was a three-dimensional space allowing them to adjust their activity patterns to the daily shift of temperature and humidity.

To estimate the number of hutias on the island, I marked out a census area roughly one acre in size. After numerous observations and counts, I concluded that the habitat was supporting twelve hutias per acre. The density of hutias seemed to be similar on all parts of the island. I also counted their fecal pellets, which were present everywhere. They indicated that the animals are probably evenly distributed over the island's surface. With a thousand acres of land suitable for their use, there might be twelve thousand hutias on East Plana Cay. Even if this rough estimate was high, the hutia population was dense. The average hutia weighs just over one and one-half pounds. In terms of biomass, the population estimate would yield nineteen pounds per acre. This is a very high figure com-

Most of East Plana Cay is an impoverished semidesert in which hutias are the dominant species.



pared with herbivorous mammals in other semiarid habitats. In fact, it is a high biomass for a single species of mammal living in much more productive areas.

The hutias have no predators. This in itself is unusual, because almost every herbivorous mammal population coexists with predators that influence their numbers. The only other mammals on East Plana Cay are small bats, and the only large predatory birds are fish-eating ospreys. The hutias are by far the dominant form of life in a very simple and depauperate plant and animal community; they have no significant competitors for their food supply or living space.

These preliminary findings raised so many ecological problems that even as I left the island I began to make plans to return. How did the hutias manage to live at such a high density? The high biomass indicated that they were living at, or close to, the carrying capacity of the environment. Did their numbers fluctuate widely the way those of lemmings or hares do in ecosystems of limited diversity such as the northern tundras?

There were some hints that the hutia population had been both stable and high for a long period of time. First, the island vegetation showed no indication of uneven utilization over the years—periods of overgrazing followed by periods of released growth. Second, the original description of plant life made by Rev. Ingraham in 1891, when he captured the first Bahamian hutia known to science, was nearly identical to what I encountered 75 years later. Ingraham also told of finding hutias in great abundance at the time of his visit. If this long-term equilibrium between food supply and a high population density is true, then two sorts of information are needed to understand it better: (1) the relationship of the animals to the plant supply and (2) their reproductive and growth rates, social interactions, and use of space.

I was able to get permission from the Bahamian government to return with assistants to East Plana Cay in October, 1967, March, 1968, and, most recently, in January of this year. Permission was also granted to allow me to take some live animals for behavioral research and to donate specimens to zoological parks for breeding stocks.

On all three visits to the island, I quickly determined that the hutia population had not changed in

Hutias need very little water and can survive on moisture provided by the leaves of succulent shrubs.

abundance since 1966; the population counts were similar to those made on the first trip.

The composition in size and sex of the individuals examined during my four field trips was similar, with a range in weight from six to seven ounces to about two pounds, and with a nearly equal proportion of males and females. The similarity in the structure of the population in fall, winter, and spring suggests that breeding is continuous and stays at a low rate throughout the year.

Restricted breeding seasons in animals are adaptations to seasonal changes in climate, food supply, and perhaps in a few cases, to the presence of enemies or to the social need to synchronize reproductive phases. On East Plana Cay there is fairly constant temperature and rainfall throughout the year. The vegetation eaten by the hutias is essentially the same in fall and spring. Some plants flower in the fall, some in the spring, and others at both seasons, and the size and condition of leaves appeared similar at all times. Breeding in the Bahamian hutia is, therefore, not restricted by environmental factors.

Some hutias were emaciated, with mangy fur, large sores and scabs on their bodies, and watery or nearly blind eyes. On the third trip, six of forty-one animals examined had these symptoms of ill health. The high percentage of sickness indicates that disease probably plays a significant role in maintaining a stable population. Evidence based

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on tagging experiments I conducted seemed to indicate that these sick hutias were very old.

Measurements of the amounts of food eaten by captive hutias temporarily penned on the island, together with the total estimated population, were utilized to estimate total food consumption. A rough guess of the productivity of the plant community was reached by using ecological measurements of other desert shrub communities. With these approximations we calculated that the hutias consumed 12.9 percent of the new plant growth each year. This is only an estimate, but it is considerably higher than the 0.2 to 2.0 percent consumption of yearly plant production reported for rodent populations in temperate grasslands and forests. Only voles and mice at their peak population explosions and the large mixed herds of hoofed animals on savannas consume a higher percentage of new growth than hutias. The hutias clearly dominate their ecosystem.

Hutias are able to maintain themselves very well with very little water. Physiological studies done on the captives showed that they produce a highly concentrated urine and can survive on the moisture gained from plant food. During all my time on the island I found fresh water only once, in a small depression three inches deep on the rock surface.

In October, 1967, we brought a dozen hutias back to the laboratory at the University of Rhode Island, and added six more to this group the following March. Bob Howe, a

In a holding pen on East Plana Cay, Bahamian hutias tolerated close contact without the aggression common to many other rodents.

graduate student in zoology at the university, studied them and their offspring for the next two years. During this time six young were born, all in litters of one. The animals were kept in groups of two males and two females, and Howe found that all of the individuals participated in amicable social behavior except when females were in estrus. Then the males showed aggression that revealed a weak dominance hierarchy. Included in their repertoire of behavior patterns were such social activities as wrestling, mutual grooming, and marking with urine.

We had first noticed the urine-marking behavior on the island. While exploring in the daytime, my field assistants and I came upon drops of concentrated urine on the sand. We soon discovered it deposited in thin, continuous lines a foot long on twisted sticks and roots. It is most likely that this purposeful deposition of urine is a marking device that serves as a means of social communication.

The ritualized marking behavior was exhibited by both males and females whether or not a female was in heat. Howe found that the urine is an important olfactory stimulus. Hutias prefer to mark over an object that already has urine on it, and it may be that the marking response to fresh urine is a useful social organizer for the nocturnal hutia. There is no indication that the marking serves a territorial function as urine deposition does in many mammals. Hutias in captivity demonstrate no territorial behavior, and because the newborn are precocial, with no nest involved, there is no need to localize protection or feeding of the young. In some instances it appeared that marking served as a threat to another hutia.

The conclusions of Howe's study, together with the observations made on wild animals, show the hutias to be compatible creatures living in a loose social structure. They do not have distinct territories, strong hierarchies of dominance-submission, or division of roles into leaders and followers. Howe concluded that their marking behavior promotes the social organization by maintaining familiarity between individuals as well as communicating physiological and reproductive conditions. Mutual tolerance characterizes their social relationships.

The hutias' notable lack of aggression places them at the opposite extreme from lemmings, which are among the most antisocial and antogonistic of all rodents. For two and a half years I observed lemmings in Norway, both during natural population peaks in the mountains and under confined conditions. There are tremendous contrasts between hutia social behavior and that of Norwegian lemmings at high density.

The lemmings' extremely high level of social intolerance serves as a stimulus to their spectacular mass emigrations. During times of high population two male lemmings cannot survive together at close quarters. The mass exodus of the late summer and fall from the mountainsides of Scandinavia is an expression of individual search for living space in a favorable habitat. Even when they are on the march lemmings maintain their solitude, avoiding each other like the opposite poles of magnets.

Contrary to popular myths, however, each lemming retains its normal behavior regarding dangers, obstacles, and requirements for food and shelter.

In the crowded lemming pens that I studied, conflict rose to such a degree that maternal behavior broke down, many young perished from neglect and disturbance, and cannibalism became common. The enforced crowding in these pens led to a deathly lethargy for some adult lemmings, including many pregnant females. Normal defense and escape responses to aggression were suppressed until eventually the lemmings seemed deprived of the will to live and they withdrew completely from social contact. Even under such unnatural conditions, however, mating, conception, and birth continued so that the reproductive rate was as high as in the earlier, uncrowded stages of these populations. Most of the lemmings die after a population peak, and the mortality is related, in some way still unclear, to the stress of crowding. But over the thousands of years since the retreat of the northern ice sheets, the lemmings have successfully and ideally adapted to their

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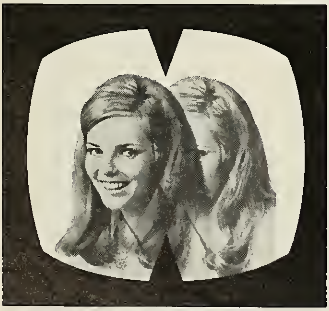

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harsh and unpredictable environments and to their numerous enemies.

When comparing the high density of the two rodent populations, it must be remembered that for hutias this appears to be a constant condition while for lemmings it is a sporadic one. The reproductive rate in hutias is very low; in lemmings, very high. Aggression and intolerance in hutias are very low; in lemmings, very high. All other small mammals studied in nature and in the laboratory seem to fall between these two extreme species.

Lemmings have been so often used as a model of an animal's irrational and disastrous response to crowding that their name is now frequently used to portray the dreadful destiny of humans in an overcrowded society. Yet there is no more reason to use the lemming's life history than the hutia's for allegories on our own history and future. What emerges as we compare these two animals, or in fact any series of mammals or birds, is that their habits and social organizations are closely related to their particular ecological niches and the roles they play in their complete community.

Hutias don't seem to fit the generalities that apply to most small mammals. Two common responses to high-density living are displayed in free-living and confined populations. These are emigration and/or increased aggressive behavior. When possible, animals move away from an overcrowded area. If flight is prevented, as in the many experiments with penned rats and mice, aggressive behavior may increase to a pathological degree, disturbing the entire social structure of the colony.

Hutias on their tiny island exist in a confined situation. They have responded to high density by developing great social tolerance, managed in part by elaboration of a system of social communication built on scent marking. A third response to high density observed in some mammals is a shift from an organization of individual territories to an organization of social hierarchy by ranking. Hutias did this to a limited extent only in the laboratory. Their well-developed scent communication system probably serves as an organizational feature to these ends.

Ecologists today believe that diversity of forms in a living community or complexity of the food web enhances the stability of the various forms of life within the community. Limitation of forms and simplicity of interrelationships are thought to underlie instability of numbers and production. The fluctuating lemmings of the impoverished tundra and the relatively constant numbers of small mammals in the complex tropical forests conform to these expectations. The hutias of East Plana Cay are part of a simple ecosystem that does not conform.

One beauty of small islands, among many, is that they may be easily considered microcosms. East Plana Cay allows us a clear view of certain basic features of a total ecosystem. Its total resources are limited, as they are in all ecosystems. The soil nutrient and fresh water supply are low, allowing only a low productivity by plants. The recycling of nutrients is slow. The major food chain links are minimal: plant to hutia, then back to soil nutrients. The harshness of the environment and the lack of suitable colonizers from the outside has led to the perfection of relatively few forms of life.

The few successful occupants of East Plana Cay dominate the island's available energy and material resources to an extreme degree. The consumer trophic level has become a near monoculture. Nearly all available space is filled with hutias. This monopoly of hutias has been achieved in the absence of predators and near absence of competitors. It requires low reproduction evenly distributed throughout the year, a high mortality related to high disease, a rare and a passive, mild behaviorial repertoire.

The total island ecosystem is a self-renewing one that preserves stability. However, the system is susceptible to disruption and even destruction from without. A violent hurricane or the introduction of a predatory mammal could upset this balance so that hutias could suddenly become extinct. Their stable, high-density population is maintained only under very specific conditions and by definite adaptations and concessions in behavior, reproduction, and mortality. □

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The Ministry of Public Health itself operates several other institutions that provide research and health care education in North Vietnam. The Materia Medica Institute is one of these. At its Van Dien station just outside Hanoi and at affiliated pharmaceutical laboratories in the city, Dr. Nguyen Van Dan supervises medicopharmacological research, one result of which is the publication of the first *Vietnamese Pharmacopoeia*, in preparation since 1963. Written by a team of more than a hundred doctors and pharmacists, its six hundred monographs describe general methods of analysis, plants, chemicals, medications, and vaccines. A second volume describing traditional medicines was begun in 1970 and is expected to be ready in five or six years.

The Materia Medica Institute also supervises plant research at ten botanical stations and the testing of medicines at about twenty laboratories dispersed throughout the country. About two thousand villages in the countryside maintain medicinal gardens. Through its various agencies, the institute also runs seminars, colloquia, and symposia, and has some students doing theses.

The ten-hectare Van Dien station specializes in tropical botany with emphasis on the introduction and acclimatization of new medicinal plants that will ultimately be propagated and used at agricultural cooperatives. In 1971, the station's garden was producing one thousand common medicinal plant species and steadily acquiring new species from peasants who had developed their own remedies, notably a cure for diarrhea. Many of the display gardens, production fields, and seed-multiplication plots were destroyed during the air war when the station was bombed seven times. Although some of the damage had been repaired, several large craters remained, and not all the plant species lost had been replaced.

One of the Materia Medica's Hanoi laboratories resembles our Food and Drug Administration in that it heads a network for testing medicines, with branches in every province. Other laboratories study the

Continued from page 24

chemical composition of medicinal plants, carry out chemical and microbiological analyses of antibiotics, vitamins, plant derivatives, and clinical samples, and practice pharmacognosy and forensic medicine. The library is well stocked with Russian and German texts but contains only a few American reference works.

The National Institute of Hygiene and Epidemiology, where Huang Thuy Nguyen is director, was dispersed in the countryside during the air war, but is now back in Hanoi. In 1971 its staff of five hundred included ninety-eight teachers with candidate's degrees—many of them women—most of whom were also professors at the medical or pharmacological faculty of the University of Hanoi. In addition to coordinating the work of the provincial hygiene and epidemiology stations already described, the institute's activities include seven divisions for research, one for laboratory animals that also has farms and colonies in the countryside, a library, and a school of microbiology and chemistry. I visited several research laboratories engaged in such studies as the growth of pathogenic organisms, serological typing, and preparation of antiserums and vaccines.

The institute's school offers a three-year course leading to a medical assistant's diploma. It accepts about fifty students a year, mostly women, who ultimately staff hospitals, laboratories, and provincial epidemiology stations. First-year training includes general physiology, chemistry, physics, and anatomy; in the second and third years, students specialize in either chemistry or bacteriology. The school also has some postdoctoral medical students who are working for specialist's diplomas.

The laboratories in all these educational and research institutions were clean and orderly. Their facilities included a remarkable variety of foreign instruments—an East German Zeiss spectrophotometer, a West German Leitz fluorescence microscope, a French Jobin Yvon vaporphase chromatography apparatus, pH meters from China and Denmark, a Japanese inverted cell

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culture microscope, an electrophoresis apparatus from the Soviet Union, a Hungarian polarograph, and so on. Nevertheless, equipment and materials were obviously in very short supply.

In addition to the extensive library of Hanoi's Polytechnic Institute and smaller libraries in other institutions, scientists may use the Central Scientific and Technical Library in Hanoi, which is directed by Mr. Tran Mai. Started in 1957 as an outgrowth of the Far Eastern Archaeological Library founded by the French in 1901, the collection at the Technical Library numbers some 150,000 books and 4,000 periodicals. Library facilities include microfilming but not photoduplication. Most texts are in foreign languages, mainly Russian, with English the next most widely available, followed by French, German, and Japanese in that order. Distribution of Chinese journals was interrupted during the Cultural Revolution but has now been resumed. In general, older people read French and English, while younger people read Russian and Chinese. French scientists have recently sent ten thousand of their leading books in various scientific fields, including monographs, textbooks, and mimeographed materials, and gifts have also been received from other countries, including the United States. But books and recent periodicals are in very short supply.

These observations of medical care in the DRVN, although limited, give a powerful impression of a nation with the intelligence and capacity to produce widespread medical benefits with extremely curtailed resources. In spite of ideological and political differences with the North Vietnamese, Americans surely will come to admire their tenacious hold on their scientific and medical heritage and their determination to make it expand to benefit all the people. They deserve an abundance of international aid in rebuilding the medical institutions of their shattered country. It is my hope that such aid, including American, will soon be possible and that from it will spring the scientific contributions to be expected of this remarkable people.

Columnist Arthur W. Galston teaches biology at Yale University.

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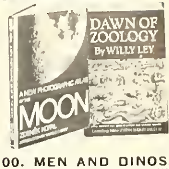

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The Myths in Men's Minds

From Honey to Ashes, by Claude Lévi-Strauss. *Harper & Row, Inc., $16.00; 512 pp.*

The publication in English translation of *From Honey to Ashes,* the second volume of Lévi-Strauss's ambitious four-volume work, *Mythologiques* (or as the English translators have it, *Introduction to a Science of Mythology*) provides an opportunity to take stock of Lévi-Strauss's enterprise as a whole. First, a cautionary note: *From Honey to Ashes* refers heavily to the earlier volume, *The Raw and the Cooked* (Harper Torchbooks, 1969). Readers are urged to begin with the latter before reading the present volume. A short summary of the first volume is provided at the beginning of *From Honey to Ashes,* but this gives little idea of the wealth of material and much of the argument presented in the earlier book. The summary will prove most useful to those who have already read *The Raw and the Cooked* and may still be wondering what the point of it all was.

The Raw and the Cooked dealt with several "groups" of South American Indian myths, the most important of which concern the origins of cooking fire, the most important meat animals (wild pigs), and agriculture. *From Honey to Ashes* focuses on two further groups, those concerned in some way with the origin or qualities of honey (which is treated ambivalently—now as delicious to eat, now as poisonous or as causing madness or uncontrollable cravings) and those dealing with tobacco. The rationale for this selection is a typical example of Lévi-Strauss's mode of procedure. Honey is a natural substance, but it can be consumed directly as a food without cooking: hence it is, in a sense, the opposite, or inverse transformation, of meat, the prototypical human food that must be cooked. Tobacco, on the other hand, is cooked (burned) but is not directly consumed as food; instead, it is reduced to inedible ash (the "ashes" of the title refers to tobacco ash), and only the smoke from its "cooking" by fire is consumed. Honey and tobacco are thus in a sense opposite transformations of cooked food (meat) and thus related as complementary inversions to each other. There is, moreover, a more direct connection, since honey is obtained by *smoking* out the bees from the hive or tree. Honey also seems to play a role in myths concerning the origin of feather necklaces, which are often burned for magical purposes to make smoke. Tobacco and smoking play a role in many of the myths relating to the origin of wild pigs, and thus are indirectly related to cooking fire by their association with meat. Feathers, on the other hand, play a key role in the myths accounting for the origin of cooking fire; typically these involve an episode in which a boy is sent up a tree or cliff to capture macaws for their feathers by his brother-in-law or father-in-law, who then leaves him marooned in the nest.

And so it goes. The object is to establish groups of myths, then to establish links, whether of transformation (inversion) or of common themes, between the groups, thus constituting more complex "groups of groups." The process is continued until all of the myths that can be related in any way to the group (or rather, to such of their symbolic elements as Lévi-Strauss has seen fit to incorporate in his often highly abbreviated models of their structures) are subsumed as new dimensions or transformations within the ever expanding group of groups. The boundaries and structural properties of the latter thus continue to change as new dimensions and elements are added.

This Protean construct constitutes Lévi-Strauss's model of the structure of mythical thought. Such a construct, derived from the comparison of hundreds of myths from scores of different societies, is said to represent a substratum of "mythical thought" common to all of the societies whose myths have been found to belong to the group. All of the individual myths of the group, conversely, are said to be (necessarily) partial expressions or permutations of the underlying, common metastructure of mythical thought revealed by the analysis.

What then is the source of this common metastructure? Conversely, what is the reason for the multifarious transformations represented by the hundreds of widely varying myths of the metagroup?

According to Lévi-Strauss the structure of mythical thought constantly permutes and adapts itself to the particular environmental conditions—flora, fauna, climate—and social conditions prevailing in specific tribes and areas. This is how myth "variants" are produced. It might be asked—given this spontaneous tendency for myths to adapt themselves through modifications in structure and content to different local conditions—what basis remains for the preservation of the common metastructure that forms the principal object and the major working hypothesis of Lévi-Strauss's analysis? The answer implicit in Lévi-Strauss's writings is that beneath the level of specific social and environmental forms, and the structural variations or permutations associated with them, is a level of common problems (for example, the distinction between nature and culture) and aspects of objective experience (substances like fire, water, honey, and tobacco; ac-

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tivities such as cooking, hunting, eating, and sexual intercourse). These common entities, or rather the structure of logical or symbolic relations among them, constitute the common metastructure that the myths of each individual society restate as variants in terms appropriate to local conditions, without ever fundamentally altering their underlying logical forms.

Lévi-Strauss establishes beyond reasonable doubt that many, if not all, of the scores of societies whose myths he considers attribute similar symbolic meanings and functions to a number of common objects, activities, and themes (fire, cooking, silence as contrasted with loud noises, jaguars, macaws). He shows, in short, that the native peoples of South America make pervasive use of a sort of "concrete logic" using the same symbolic elements or dimensions in similar ways. This is a fascinating discovery, but does it justify Lévi-Strauss's theoretical account of it?

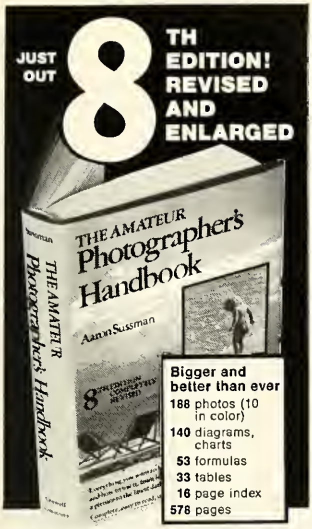
The societies of tropical South America inhabit ecologically similar areas, have similar economies, and possess a fairly restricted range of social institutions. They utilize the same flora and fauna in the same ways; the same substances, relations, and activities therefore tend to have the same associations for them. Could not the similarities in the symbolic uses of such elements in their myths be largely or wholly accounted for by reference to such common aspects of experience (a position quite consistent with Lévi-Strauss's own contentions in *The Savage Mind*) without postulating an elaborate metastructure from which they must be derived? This view would regard the locus of "the structure of myth" as inherent in particular myths, and regard the similarities among different myths, like the variance among different versions of what is obviously the same myth, as the outcome of similarities or differences in the contexts of the myths, in the messages each is attempting to convey, and in the symbolic elements drawn upon in their composition. The pattern of relations among different myths would, in short, be regarded as the result, not the cause, of the form and content of particular myths. The structure of each myth, by the same token, would be considered to have a definite focus, or "center," in its relationship to its cultural setting and the message it conveys about that setting, rather than to constitute merely an emanation of an unfocused and unbounded metasystem.

This interpretation runs directly counter to Lévi-Strauss's major thesis, but it seems to me far more tenable on the basis of his evidence.

The evidence and its interpretation are obviously the critical issues in evaluating Lévi-Strauss's claims and the counterclaims of his critics. It is commonly recognized that on this score Lévi-Strauss causes even his most devoted followers considerable embarrassment, while more hostile critics have seized upon his often cavalier and unreliable handling of data as grounds to dismiss ideas from serious consideration. It is true that he often gets his facts wrong or misinterprets his evidence to fit his argument. The grounds he gives for considering a pair of myths as "transformations" of one another, or as dealing with the same theme in different ways, are sometimes so farfetched as to amount to what one critic has called "verbal sleight of hand" and another "self-parody."

There is, however, a far more serious objection to be made to Lévi-Strauss's analyses of South American Indian myths than his not infrequent ethnographic errors or farfetched interpretations of particular myths. This objection concerns the adequacy of his basic notion of structure itself.

The central problem of structuralism in its Lévi-Straussian form is the failure to develop an adequate concept of structure. This failure is no mere paradoxical shortcoming or incidental flaw in the theoretical apparatus. On the contrary, it is the direct outcome of Lévi-Strauss's most fundamental theoretical (one might almost say metaphysical) premise, to wit that "structures" at the cultural level, and above all, myths, directly reflect the patterns of human thought, considered as a psychological process. "Anthropology," Lévi-Strauss has declared, "is first of all a psychology." By "psychology" Lévi-Strauss emphatically does not mean the structure or processes of the individual psyche per se, with its (for him) irrelevant properties of consciousness and af-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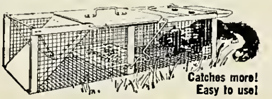
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fectivity. He has in mind, rather, the unconscious processes of association of cognitive and perceptual stimuli into simple patterns common to the human species as a whole and independent of (because prior to) the consciousness of any individual member of it.

The question is whether such elementary patterns are adequate models for the sorts of cultural structures, for example, myths, that Lévi-Strauss sets out to reveal. It is significant that his models are taken from the lower levels of psychic and linguistic structure, specifically the levels below those directly involved in conscious, purposive action or communication by actors or speakers. Lévi-Strauss's structural models, in other words, preclude any role for the acting, oriented subject.

Now it is one of the salient properties of myth and other higher cultural forms that they explicitly or implicitly concern acting subjects. These "subjects" symbolize patterns of thinking, acting, and feeling that a culture deems appropriate for collective categories or classes of actors; they do not concern individuals per se. Significant aspects of the "message" coded in myths, and of their structures as well, concern or reflect the culturally patterned "subjective" points of view from which the actions and situations they symbolize are stated. Collective subjects in this sense, like other relatively complex dimensions of message, tend to be fully reflected only at the higher levels of organization of cultural structures (for example, the plot structures of myths), which Lévi-Strauss's "structural" models tend to ignore.

This entire aspect of the structure and message of myths and of thought itself is missing from Lévi-Strauss's conception of structure. This is the major reason why he has never been able to formulate a consistent analysis of the relationship of myths to their social and environmental contexts or to develop a satisfactory analysis of the messages or cultural meanings myths have for the people who tell and listen to them.

Lévi-Strauss's elimination of the subjective factor leaves him with no basis for distinguishing between the structure of thought (or of lan-

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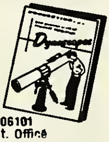

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guage) and the structure of what *is* thought (or spoken), namely the mental and linguistic images and constructs that cultures or individuals employ to "say something of something." If the play has no actors, it can only be about the stage set and the script. For Lévi-Strauss the ultimate message of all thought turns out to be simply the structure of thought itself. Likewise, the message of cultural symbolic forms, and most especially and directly of myths, turns out to be the basic structure of thought, which constitutes at once its source and its medium. This "thought" is itself treated as taking form in spontaneous response to the properties of objects (preferably, if Lévi-Strauss's examples are any guide, "natural" objects) and the collective patterns imposed on thought by culture are ultimately to be explained, it seems, in the same way—as the outcome of the encounter of thought with a particular environmental situation.

Lévi-Strauss's concept of the structure of myth, and a fortiori, all other cultural constructs, thus constitutes a far more radical attempt to reintegrate culture and nature than any of the aboriginal myths whose structures he analyzes. Whereas the latter tend to treat culture as a sort of tenuous and ambiguous transcendence of nature, Lévi-Strauss seeks to achieve the reverse transcendence by making culture disappear again into nature—as personified by the ultimate natural object, the human mind itself.

Terence Turner is an associate professor of anthropology at the University of Chicago. He is the author of The Fire of the Jaguar, *a book on the myths of the Ge and Bororō tribes of Brazil.*

The Jívaro, by Michael J. Harner. *Doubleday/Natural History Press, $7.95; 233 pp., illus.*

This thoroughly interesting book is based on fourteen months of field work among the Jívaro Indians of eastern Ecuador. Like most ethnographies it is organized around the technological, social, and ideational aspects of culture. But unlike most ethnographers, Harner avoids a stuffy impersonal attitude toward the subjects, whom he presents as his friends and helpers.

Although the Jívaro have long been regarded as unique and even bizarre, being the most warlike people in the Americas, the author has succeeded in communicating an understanding of them as human beings with basic needs and responses like our own. This is accomplished in part by a writing style marked by subtle humor and occasional metaphors taken from our own culture, as, for example, "party dress," "kilt," and garden "fairies" (who live underground and push up the crops). Particularly valuable in this respect also are transcriptions of some representative events, such as the ethnographer's log of a couple's daily subsistence routine, an extended morning monologue of a father to his son, an origin myth, and a shaman's song. Harner's photographs contribute much to the book, by both their fine quality and their wealth of significant cultural features, not all of which are made explicit in the text.

The first chapter spells out in considerable detail the nature of Jívaro contacts with other Indians and with whites (called *apači* by the Jívaro). In reading this account one finds the familiar sequence of exploitation, competition for resources, and depopulation by conflict and disease; and in addition one develops an understanding of just who the Jívaro are and how they relate to the peoples around them.

In a chapter on shelter, subsistence, and technology, Harner provides quantitative data on production and consumption, especially on the shifting cultivation of manioc, that will be of particular use to cultural ecologists.

The section on social relations includes information on the life cycle, relations among kin, the leadership role of shamans, and the function of trade in maintaining intergroup relations. Embedded in this analysis are a number of interesting details of social organization that are currently of concern to lay readers as well as anthropologists. These in-

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clude discussions of romantic love, the problems of polygyny, adultery with the resulting hostilities and alienation of relatives, intergroup conflict, and alliances for war and marriage.

In the sphere of social control we learn the relation of the vaguely defined authority of "big men" and shamans to their power to kill, power that is reinforced by their exploits in war and witchcraft. It seems significant that in this society, where an extraordinary amount of interpersonal tension prevails, an unusual variety of souls and spirit helpers are available for use in manipulating the behavior of actual and suspected enemies. Such an elaboration of supernaturalism calls to mind the recent efflorescence of religious practices in our own society, where an increase in interpersonal tensions has accompanied a lessening in the strength of traditional social norms.

A chapter on law, feuding, and war includes a very brief section on the making and celebrating of *tsantsa* (shrunken heads). The brevity of this treatment suggests that the author wished to avoid the sensationalism that has been attached to this most notorious feature of Jívaro culture. Jívaro head shrinking may be regarded as the last remnant of the practice of taking heads and shrinking scalps that was formerly widespread in northwestern South America and Mexico. Although

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Harner makes no attempt to account for the origin of the war complex, he has pointed to some of the factors that serve to perpetuate a cycle of punitive retaliations following death. In this connection he presents a particularly timely discussion of the effect of purposefully educating boys to become avenging killers.

A final chapter discusses recent changes that have followed the introduction of new materials from white settlers and the neighboring Achuara. The value of this survey is considerably heightened by recording the natives' own views of the causes of the various changes.

In contrast to the sympathy with which the Jívaro are treated in this book, a jarring note is struck in the Introduction by dismissing as erroneous most of the content of the "only [other] two serious major works" on the Jívaro, those of Raphael Karsten and M. W. Stirling, without, however, specifying the errors. Harner writes, "Except for Stirling's data on material culture, I found that there was scarcely a paragraph of ethnographic information in either work that could be considered wholly accurate." Such a sweeping rejection is not entirely convincing and leaves the reader to assume that some of the differences in earlier reports might be attributed to variations in practices among the numerous groups of Jívaro. Of course it is not possible or desirable in a book of this type to describe all the variations in Jívaro culture, and Harner has already published elsewhere a discussion of some of the early errors ("Jívaro Souls," *American Anthropologist*, 1962). Moreover, he promises specific criticisms in specialized publications to appear later. Specialists will look forward to these publications with interest.

Despite this minor reservation, Harner's thorough and careful field research has resulted in a far more complete and accurate account of Jívaro culture than has been available until now. It is a very good book and one that deserves a more professional printing job, specifically, fewer typographical errors, more durable paper, evenly cut pages, and covers that do not warp.

GERTRUDE E. DOLE
State University of New York
College at Purchase

The wooden lip plug is a common adornment for women.

CONSERVING LIFE ON EARTH, by David W. Ehrenfeld. *Oxford University Press, $10.00; 360 pp., illus.*

This is a time of ecological backlash—the minions of the industrial consumer society are mustering their forces and attacking.

The vulnerability of the environmental movement to such attack is partly real. The ecological bandwagon has drawn a motley passel of malcontents and a million spokesmen, experts in many professions, who know and care little about the whole natural community. By and large, ecologists are a quiet lot, and everybody from farmers to bankers has spoken for them. David Ehrenfeld is an ecologist. His book, at this stage in public sensibility, may be viewed as reactionary ecological environmentalism. It is an extremely valuable addition to a literature in shocking disarray and in danger of losing its center.

Ehrenfeld calls himself "an advocate for the natural world." His main theme is the loss of natural diversity. The wisdom of this theme is based on the capacity of world ecosystems to recover—no matter how badly warped by man's activity—*if* constituent species are not extirpated.

In support of his view, the author explains the basic ecological concepts of community maturity, complexity, and stability as developed by Eugene Odum and Ramon Margalef. Because of the irreversibility of extinction and the importance to the natural ecosystem of all its species, the ecological imperative of the preservation of species emerges. While Ehrenfeld is not the first to realize this, he has advanced it as man's primary concern in his attention to the life of the planet. At a time when conventions on human ecology and conferences on environmental planning are held without recourse to ecology or ecologists, *Conserving Life on Earth* is most timely.

Ehrenfeld also examines ecological theory in its historical aspect, as an emerging concern from the nine-

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Photo by Louise Bucknell

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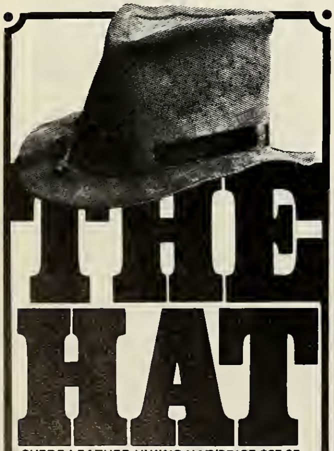

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teenth century. The particular ways in which large-scale programs and activities threaten natural communities are explained with helpful illustrations and diagrams. The genetic damage potential of the Green Revolution, the consequences of population overgrowth by man, and the effects on the landscape of strip mining, war, development, pollution, pesticides, and the introduction of exotics are described in relation to natural communities.

Separate chapters are done from the viewpoint of single species. The source of the danger of extinction varies from one to another. Most are adversely affected by environmental changes caused by man; some are imperiled by the appetite of zoos and pet keepers; others by hunting and collecting; and still others by pesticides and pollution.

The blue whale, now virtually extinct, is given a chapter to itself. Its characteristics as a vulnerable mammal, the whaling record, and the economics and politics of whale killing are all considered as part of the desperate status of this magnificent animal.

From this example, Ehrenfeld goes on to discuss the problems of species preservation in general, giving guidelines and some examples of successful legislative programs and regional planning. His comments on land-management techniques place ecology, rather than productivity or progress, at the center. This perspective puts the omniscient attitude of the forestry profession in a revealing light. For seventy years the condescending and sometimes patronizing father of American resource management, that profession now stands betrayed by its own economic preoccupations, overestimates of productivity, and the dismal failure (in the national forests) of the "multiple-use" concept. In effect, Ehrenfeld seems to say, we can no longer trust our lands entirely to resource specialists who are committed to yield and dollar values.

One of Ehrenfeld's most interesting subjects is the one he calls "analogues of natural communities." Older ecologists will recognize this as a new term for the disclimax, the stable community that includes man and his works. Without discounting the importance of wilderness, Ehrenfeld recognizes

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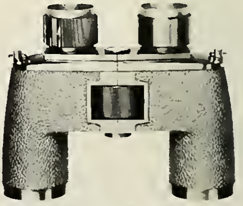

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that a future state of ecological health for the planet will include vast areas of inhabited, used land. There are examples, particularly in western Europe, of such harmonious mosaics of man and nature that clearly show how conserving life on earth can be consistent with the human enterprise.

Throughout the book Ehrenfeld attempts to rescue the term *conservation*, despite his awareness of the term's historical connection to a rather narrow resourcism and, by the late 1950s, its subversion and domination by hard-line, exploitative, polluting, big corporation, big government technocrats. It remains to be seen how successfully he can redefine and refurbish its meaning so that it will satisfy advocates for the natural world and for that rapidly growing minority in search of an alternative technology.

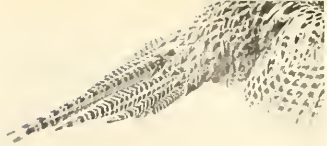
That Ehrenfeld himself is a member of both groups is clearly seen in one of his concluding statements:

> The only justification of the Western ideal of progress has been that it promotes man's comfort and well-being; but if we look dispassionately at the results of a century of progress, we find nearly all men anxious and alone. Technology, masquerading as an end rather than a means, has unnecessarily moved man away from nature, and in so doing has moved him away from himself. Even if there were no ecological crisis, conservation would still have its most important mission before it: preserving wilderness for those human beings who are fortunate enough to know now that it is part of them and that they enjoy it, and also for those in the future who may learn to use technology in a way that does not subvert the human heritage.

The book has scores of first-rate photographs and a foreword by Archie Carr.

PAUL SHEPARD
Dartmouth College

Erratum: *Natural History* regrets its error in failing to mention in the review of gardening books (May, 1973) that the "Scribner Garden Library" books are available in paperback at reasonable prices.



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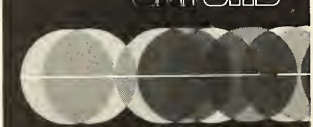

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Celestial Events

by Thomas D. Nicholson

Sun and Moon When the sun reaches the summer solstice on June 21, 1973, it signals the turning point in its apparent northward motion over the earth; to an observer on earth, in other words, the sun appears to occupy a position in the sky more and more northerly until June 21. Thereafter, it begins an apparent motion southward. The real motion that produces the effect is that of the earth around the sun in an orbit inclined to the plane of the equator.

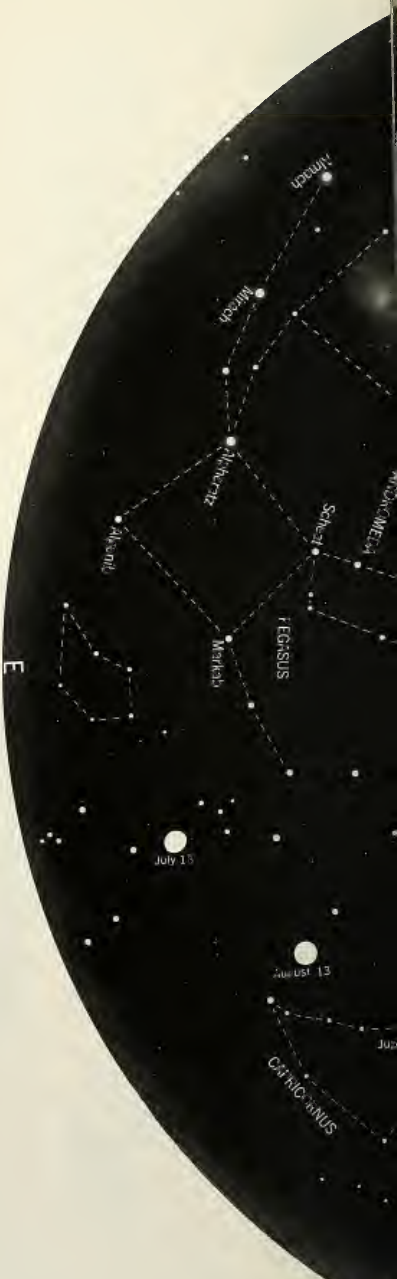
The moon, in June, July, and August, becomes full about mid-month, new about the end of each month. Dates of the phases are: in June, full on the 15th, last-quarter on the 23rd, new on the 30th; in July, first-quarter on the 7th, full on the 15th, last-quarter on the 22nd, new on the 29th; and in August, first-quarter on the 5th, full on the 13th. The new moon of June 30 comes within eleven hours of perigee; the perigee spring tides that result produce tides that are much higher and lower than the ordinary tides.

Solar Eclipse of June 30 There are three eclipses during the month from June 15 to July 15: penumbral eclipses of the moon at the beginning and the end and a total solar eclipse on June 30. Unfortunately, most of us won't see them. During a penumbral eclipse, the full moon darkens slightly because the earth cuts off part of the sun in the lunar sky, but only an expert would notice the difference. And the June 30 eclipse, of which there will be plenty to see, will take place over the South Atlantic and Central Africa. This eclipse will last more than seven minutes in places, and it will occur where climatic records suggest a better than 90 percent chance of clear skies. We may have a chance to watch this very special event on television.

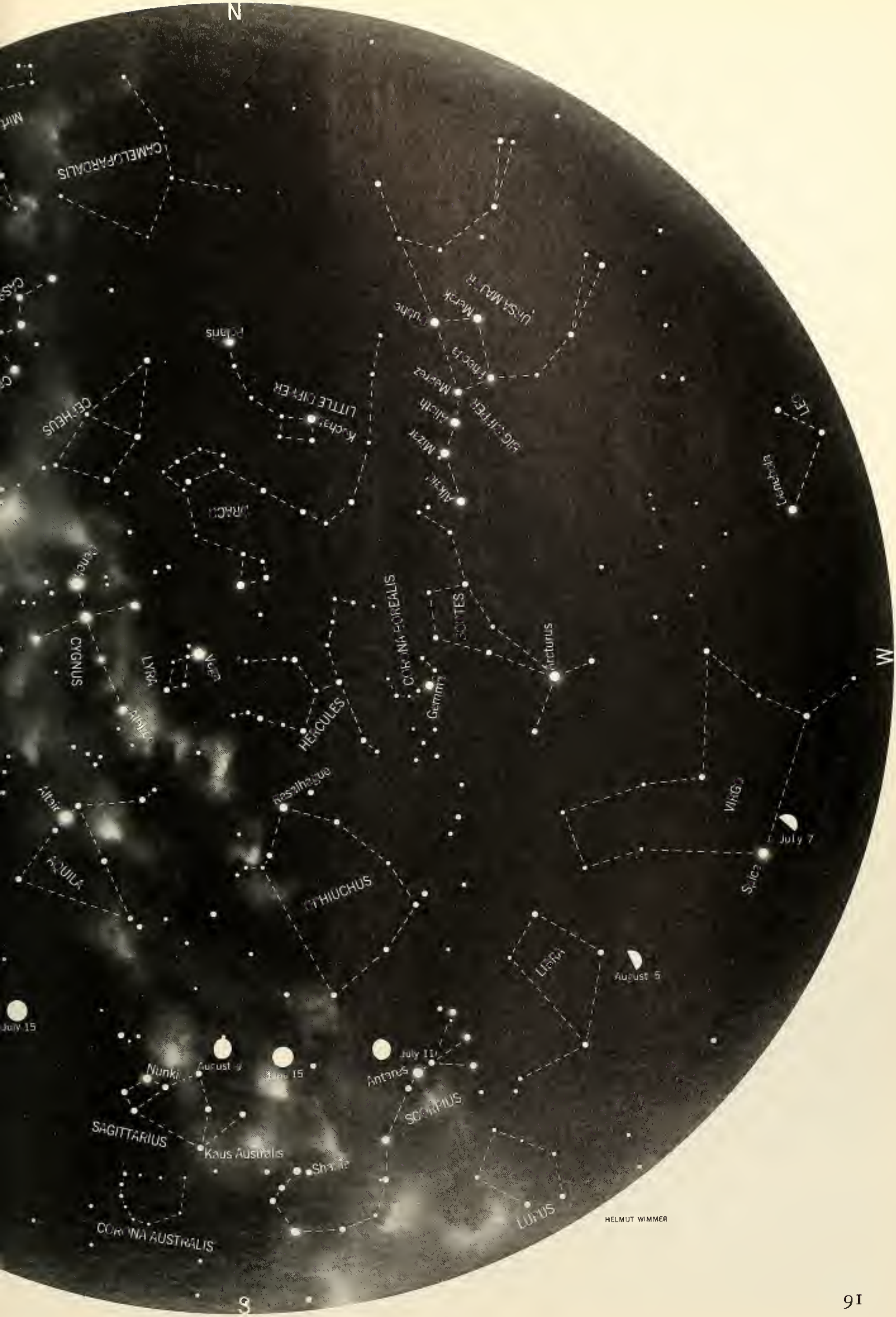
Planets Planets will be plentiful all summer, in both the evening and the morning sky. In the evening, Venus will be low in the west after sundown, Jupiter will rise in the east in the early evening, and Mars will rise in the late evening, before midnight. And in the morning, Jupiter will be in the west at dawn, Mars well up in the south, and Saturn in the east, preceding the rising sun into the sky.

Mercury will be at greatest elongation (east) in the evening sky on June 22, and may be seen for about a week before and after that date, low in the west after sundown; on August 8, it will be at greatest elongation (west) in the morning sky and may be seen for about a week before and after that date, rising in the east just before sunrise.

June 15: Penumbral lunar eclipse. Saturn enters the morning sky.
June 19: The bright object near the moon tonight is Jupiter.
June 21: Summer begins at 8:01 A.M., EST.
June 30: Total solar eclipse, not visible in North America.
July 4: Earth is at aphelion, 94,513,000 miles from the sun.
July 20: Mercury, at inferior conjunction, enters the morning sky.
July 27: Saturn is near the waning crescent moon before sunrise.
July 29: The Delta Aquarid meteor shower reaches maximum, with no moonlight during morning hours. Its meteors, averaging twenty per hour per observer, are not very bright.
July 30: Jupiter, at opposition, is in the sky from sunset to sunrise.
August 12: The Perseid meteors, the best shower of the year for number, brightness, and duration, reach maximum. But moonlight will limit observations during the after-midnight hours that are best.



★ Hold the Star Map so the direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 12:20 P.M. on June 15; 11:25 P.M. on June 30; 10:25 P.M. on July 15; 9:20 P.M. on July 31; and 8:20 P.M. on August 15; but it can be used for an hour before and after these times.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HELMUT WIMMER

Sky Reporter

The Ancient and Legendar

The sorts of scientific problems that I am involved in—the environments of other planets, the origin of life, the possibility of life on other worlds—engage the popular interest. This is no accident. I think all human beings are excited about these basic problems, and I am lucky enough to be alive at a time when it is possible to perform scientific investigations of some of them.

One result of popular interest is that I receive a great variety of mail: poems and sonnets about the plaque on Pioneer 10; requests from schoolchildren who want me to write their weekly assignments for them; letters from strangers who want to borrow money; communications from individuals who ask me to check out their detailed plans for ray guns, time warps, spaceships, or perpetual motion machines; and notices from advocates of various, arcane special interests such as astrology, ESP, UFO-contact stories, the speculative fiction of von Danniken, witchcraft, palmistry, phrenology, tea-leaf reading, Tarot cards, the I-Ching, transcendental meditation, and the psychedelic drug experience. Occasionally, there are sadder stories, such as that from a woman who said she was contacted by inhabitants of the planet Venus through her shower head and another from a man who tried to file suit against the Atomic Energy Commission for tracking his every movement with "atomic rays." A number of people write that they can pick up extraterrestrial intelligent radio signals through the fillings in their teeth, or by concentrating in the right way.

But over the years one letter in particular stands out in my mind as the most poignant and charming of its type. It was an eighty-five page, handwritten letter (in green ink), from a gentleman in a mental hospital in Ottawa. He had read a report in a local newspaper that I thought it possible that life exists on other planets; he wished to reassure me that I was entirely correct in that supposition, as he knew from his own experience.

To assist me in understanding the source of his knowledge, he thought I would like to learn a little of his personal history—which occupied a good bit of the eighty-five pages. As a young man in Ottawa, my correspondent chanced to come upon a recruiting poster for the American armed services, the one showing a goateed old codger pointing his index finger at your belly button and saying, "Uncle Sam Wants You." He was so struck by the kindly visage of gentle Uncle Sam that he determined to make his acquaintance immediately. My informant boarded a bus to California, apparently the most plausible habitation for Uncle Sam. Alighting at the depot, he inquired where Uncle Sam could be found. After some confusion about surnames, my informant was greeted by unpleasant stares. Despite several days of earnest inquiry, no one in California could tell him the whereabouts of Uncle Sam.

He returned to Ottawa in a deep depression, having failed in his quest. But almost immediately, his life's

Britannia, the personification of Great Britain, whose likeness appeared on the obverse face of the old British penny, may no longer be sitting on a throne. In 1971 Britain adopted a decimal system of currency and the old pennies were

From The Cosmic Connection An Extraterrestrial Perspective. *Copyright © 1973 by Carl Sagan and Jerome Agel. To be published in November by Doubleday & Company, Inc.*

Gods of Old

by Carl Sagan

removed from circulation. According to the theory of one of the author's correspondents, when mythical figures lose their dominion, they become ordinary mortals reduced to earning their keep like other humans.

work came to him in a flash. It was to find "the ancient and legendary gods of old," a phrase that appears many times throughout his letter. He had the interesting and perceptive idea that gods survive only as long as they have worshipers. What happens, then, to the gods who are no longer believed in: the gods, for example, of ancient Greece and Rome? Well, he concluded, they are reduced to the status of ordinary human beings, stripped of the perquisites and powers of the godhead. They must now work for a living—like everyone else. He perceived that they might be somewhat secretive about their diminished circumstances, but would at times complain about having to do menial labor when once they supped at Olympus. Such retired deities, he reasoned, would be thrown into insane asylums. Therefore, the most reasonable method of locating these defrocked gods was to incarcerate himself in the local mental institution. This he promptly did.

While we may disagree with some of the steps in his reasoning, we probably all agree that the gentleman did the right thing.

My informant decided that to search for all the ancient and legendary gods of old would be too tiring a task. Instead, he set his sights on only a few: Jupiter, Mercury, and the goddess on the obverse face of the old British penny—not everyone's first choice of the most interesting gods, but surely a representative trio. To his astonishment, and mine, incarcerated in the very asylum in which he had committed himself, he found Jupiter, Mercury, and the goddess on the obverse face of the English penny. These gods readily admitted their identities and regaled him with stories of past times when nectar and ambrosia flowed freely.

Then one day my correspondent succeeded beyond his hopes. Over a bowl of bing cherries, he encountered "God Almighty," or at least a facsimile thereof. At least the Personage who offered him the bing cherries modestly acknowledged to being God Almighty. God Almighty luckily had a small spaceship on the grounds of the asylum and offered to take my informant on a short jaunt around the solar system, which was no sooner said than done.

"And this, Dr. Sagan, is how I can assure you that the planets are inhabited."

The letter then ended as follows: "But all this business about life elsewhere is so much speculation and not worth the really serious interest of a scientist like yourself. Why don't you address yourself to a really important problem, such as the construction of a trans-Canadian railroad at high northern latitudes?" There followed a detailed sketch of the proposed railway route, and a standard expression of the sincerity of his good wishes.

Other than working seriously on a trans-Canadian railroad at high northern latitudes, I have never been able to think of an appropriate response to this letter.

Carl Sagan is professor of astronomy and director of the Laboratory for Planetary Studies at Cornell University.

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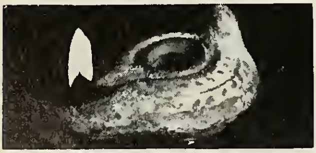

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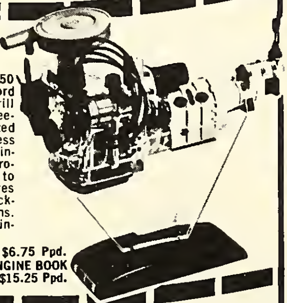

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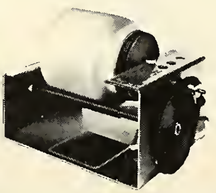

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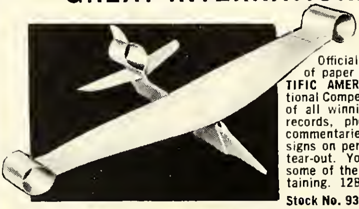

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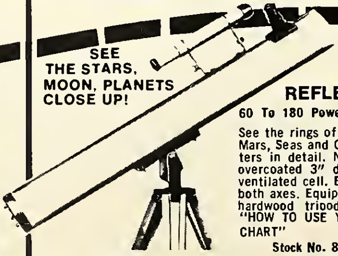

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At Random

by Milton Rugoff

It is an old habit of man's to draw his most contemptuous expressions from animals and their ways. There is hardly a more sweeping insult than to say of someone that he is an animal or, as the English put it, beastly. If someone is brutal, vicious, or uncontrolled, we attribute it to his "animal instincts."

Nothing seems to signify stupidity more fully than such terms as ape, baboon, gorilla, ox, goose, cow, birdbrained, or bullheaded. Do you want to put someone down as craven or contemptible? Then call him chicken or sheeplike, a rat, a snake, a louse, or most crushing, a worm. Just as great a variety of animals convey cruelty and ruthlessness: hawk, vulture, jackal, hyena, wolf, shark. Among the most worn clichés in the vocabulary of insult are filthy as a pig, vain as a peacock, stubborn as a mule, puffed up as a toad, changeable as a chameleon, blind as a bat, lecherous as a goat, crazy as a loon.

Indeed, there are few animals that we do not use in some way to sum up our dislikes or revulsions. An acid-tongued woman is catty and a nasty one is a bitch. Anyone we don't trust is a skunk. To harass someone is to hound or badger him. To be mad is to be batty or cuckoo. Anything we don't believe is called fishy. Even "eager beaver" is not a compliment.

These metaphors are so inaccurate, so absurdly exaggerated and anthropomorphic, that they would be funny if they were not so deep-rooted. Peacocks are not half as vain as many men and women. There is nothing crazy about a bat, chameleons change color purely in self-defense, and any ornithologist will tell you that cuckoos know well what they are doing.

There is no evidence that a baboon is stupid or that fish are untrustworthy. A pig is filthy when it is kept in a sty and fed swill. A cur well treated generally becomes a good dog. Who knows whether a randy goat is obnoxious to his lady friends? A shrew is not notably shrewish, a crab crabby, or a cat catty. Mules are called stubborn when they don't do some human master's bidding; we should commend them for independence of spirit.

Men do find some traits to admire in a few animals—even if the admiration is often casual, condescending, or just silly. We salute the courage of lions, although they seem to display it mostly in subduing weaker prey; and we think owls wise, for the foolish reason that they look so solemn. We are charmed by the meekness of lambs and the cuteness of kittens. Or we single out some minor trait, as when we speak of the gracefulness of gazelles. If there is one genuine exception, it is the dove, which has long been the symbol of love and peace. Yet, the ornithologically identical pigeon serves for such epithets as pigeonhearted and stool pigeon (originally a hunter's decoy).

In some societies animals were considered gods, as in ancient Egypt, or sacred, as in India. But the Egyptians have long since abandoned their animal deities. Only the Hindus among major peoples continue to reverence animals, perceiving them as vessels of the selfsame spirit that inhabits man. Meanwhile, we in the West use the phrase "sacred cows" with contempt.

Man's ugly view of animal behavior goes far back (the Old Testament even attributes the origin of all evil to a serpent), but the idea that man himself has outgrown his primitive and savage animal characteristics got its greatest boost a century ago from the Victorians. They interpreted Darwin's theory of man's evolution from the apes as an ascent. Evolution was a grand march upward, and man, as Tennyson declared, was in the foremost files of time.

Today we aren't so sure about all that. Perhaps at some point man began to move too far away from his animal origin, to develop a variety of unanimal (I almost said "inhuman") aberrations and unnatural tendencies: for example, fouling the earth on which he lives and the very air he breathes or making war and slaughtering masses of his fellow men. True, locusts and tent caterpillars are ruthlessly voracious, but their underlying impulse is to feed for survival.

At the same time, most studies of animal behavior in the past forty or fifty years have revealed more and more estimable charactistics in a great variety of animals: the docility and affection of creatures once thought to be intractable, such as wolves and wolverines; the solicitude of mother animals for their young, including not only such familiar examples as birds, kangaroos, and bears, but sea otters and the fish that takes its young into its mouth when danger threatens. Scientists have uncovered astonishing facts about the learning ability and personalities of, among others, dolphins and seals; the marvelous faculties that guide migrating birds and spawning salmon; the wonderfully complex social structure of termites, bees, and ants.

It is, I suppose, "only human" that, being differentiated from the beasts by our powers of speech, we should deride them. But is it too much to expect that after all these centuries we should acquire a little humility, stop assuming that we are the salt of the earth and God's gift to the animal kingdom? The problem is how to rise, not above out animal selves, but above our human selves, and acknowledge that we share the planet with an immense variety of living things, many of them infinitely more in tune with the earth than we are.

Milton Rugoff is editor of Chanticleer Press, Inc.

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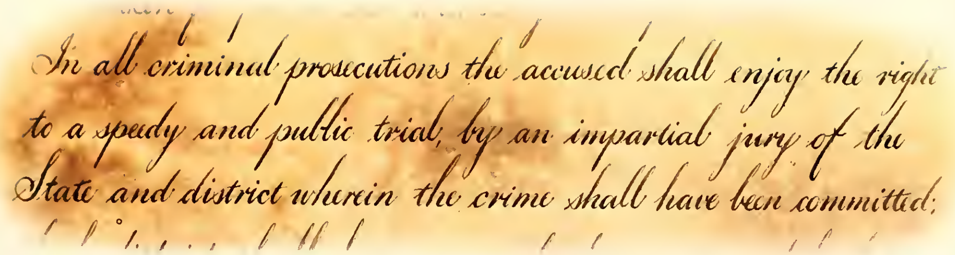

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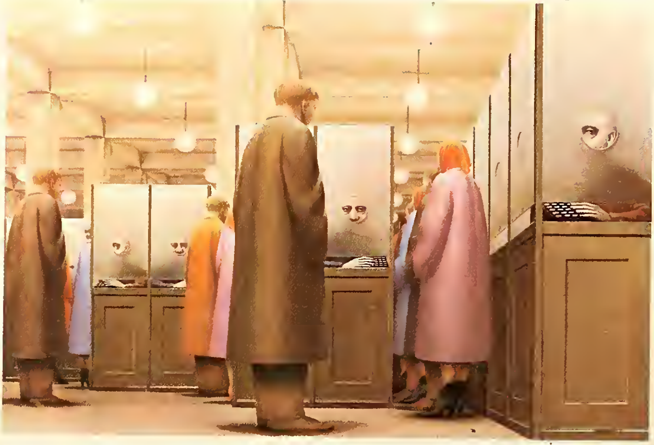

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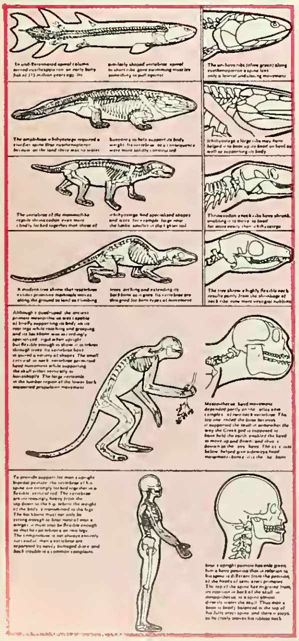

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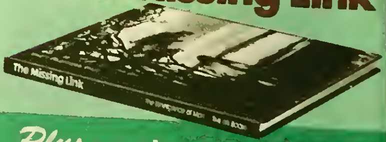
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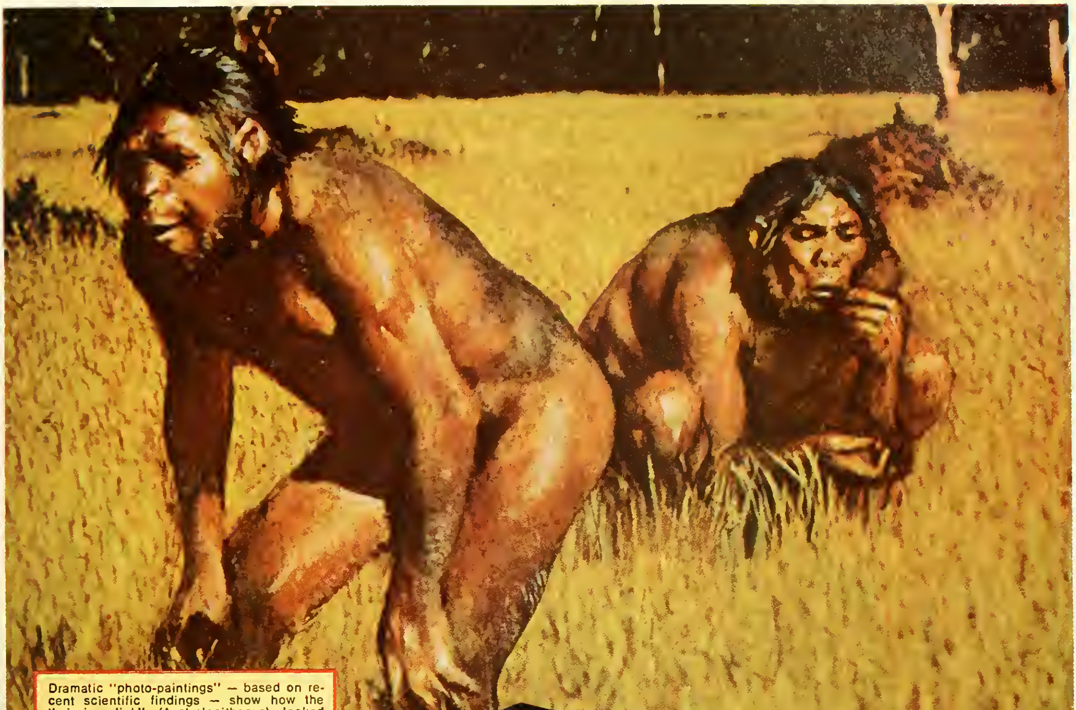

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Authors

A lifetime professional interest in the physiology of sense perception, combined with thirty years of living with dachshunds, led **Kenneth D. Roeder** to probe the retrieval antics of his current pet, Morris. By throwing a ball to his dog in their Concord, Massachusetts, back yard, Roeder provided Morris with exercise and himself with numerous insights into animal behavior. A professor of physiology at Tufts University, Roeder studies the neural mechanisms of insect behavior and for the past twenty years has been investigating the interactions of bats and moths. He has written more than sixty papers on insect brain function and is the author of *Nerve Cells and Insect Behavior,* published by Harvard University Press.

Kenneth D. Roeder

Richard E. Warner, presently a consultant in environmental biology, first became interested in the riddle posed by the decline and extinction of Hawaiian honeycreepers in 1957, when a review of the literature and his own field studies suggested that a distributional pattern was involved. Later, his position as a research coordinator with the Game Bureau, Hawaii Department of Land and Natural Resources provided him with an unusual opportunity to investigate the disappearance of many endemic birds. He has "always felt the need for personal involvement in conservation matters as a basic element of social responsibility" and is now on his way back to Hawaii to continue his work on the ecology of the honeycreepers, particularly the impact of disease. Journeying aboard his own boat, he is currently studying coastal resources and environmental problems somewhere between southern Florida and the Caribbean.

Richard E. Warner

Long drawn to the sea and its life forms, **Gilbert L. Voss** dates his interest in coral reefs to summer vacations spent sailing off the Florida Keys as a youth. He served four years in the Coast Guard, has worked as a fishing-boat captain and guide, and has conducted scientific cruises off the tropical coasts of West Africa and South and Central America. A specialist in cephalopods, Voss is professor of marine science and chairman of the Division of Biology at the Rosenstiel School of Marine and Atmospheric Science of the University of Miami. His current research includes the effects of pollution on the biotas of Florida's southeast coast and the biology of the fauna of the Puerto Rico Trench.

Gilbert L. Voss

For the past five years **Harvey A. Feit** has conducted field work with the Cree Indian hunters of northern Quebec, studying their adaptations to changing environmental and cultural conditions. Now an assistant professor of anthropology at Carleton University in Canada, he is completing his doctoral dissertation on the hunting ecology of the Waswanipi Band of the Cree tribe. When the Quebec government announced plans for the James Bay hydroelectric project in 1971, Feit became active in a number of committees concerned with how the project would affect the traditional life patterns of the Indians in the area.

Harvey A. Feit

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Since 1941, when he began a twelve-year stay in the Amazonian basin, Richard E. Schultes has been collecting and studying rubber plants, orchids, and toxic, medicinal, and narcotic plants. His research on *Cannabis* reflects his belief that if we are to understand the social and legal aspects of marijuana use, a better knowledge of its biology is necessary. Schultes coauthored, with Albert Hofmann, the recently published *Botany and Chemistry of Hallucinogens.* He is the first Paul C. Manglesdorf Professor of Natural Sciences at Harvard University and director of Harvard's Botanical Museum.

Richard E. Schultes

Tracking the movements of raccoon families via radiotelemetry was part of the graduate work done by Dean Schneider at the University of Minnesota. He has also studied the behavior and ecology of lynx in northern Minnesota. Formerly a biologist with the United States Fish and Wildlife Service, Schneider is doing free-lance writing and hopes "to return to biological research when the current Ph.D. glut is over." ☐

Dean Schneider

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Of course, not all glass goes back to the earth. But because glass is recyclable, more and more is going back to the industry for making new glass bottles and jars.

The glass industry is also continuing to develop new uses for used glass such as road paving material, construction panels, bricks, insulation, terrazzo and reflective paints.

When you add it all up, it's easy to see why consumer preference for glass containers continues to grow. In terms of its attributes, its utility and recyclability, glass is a natural. For a copy of "The glass container story," write:
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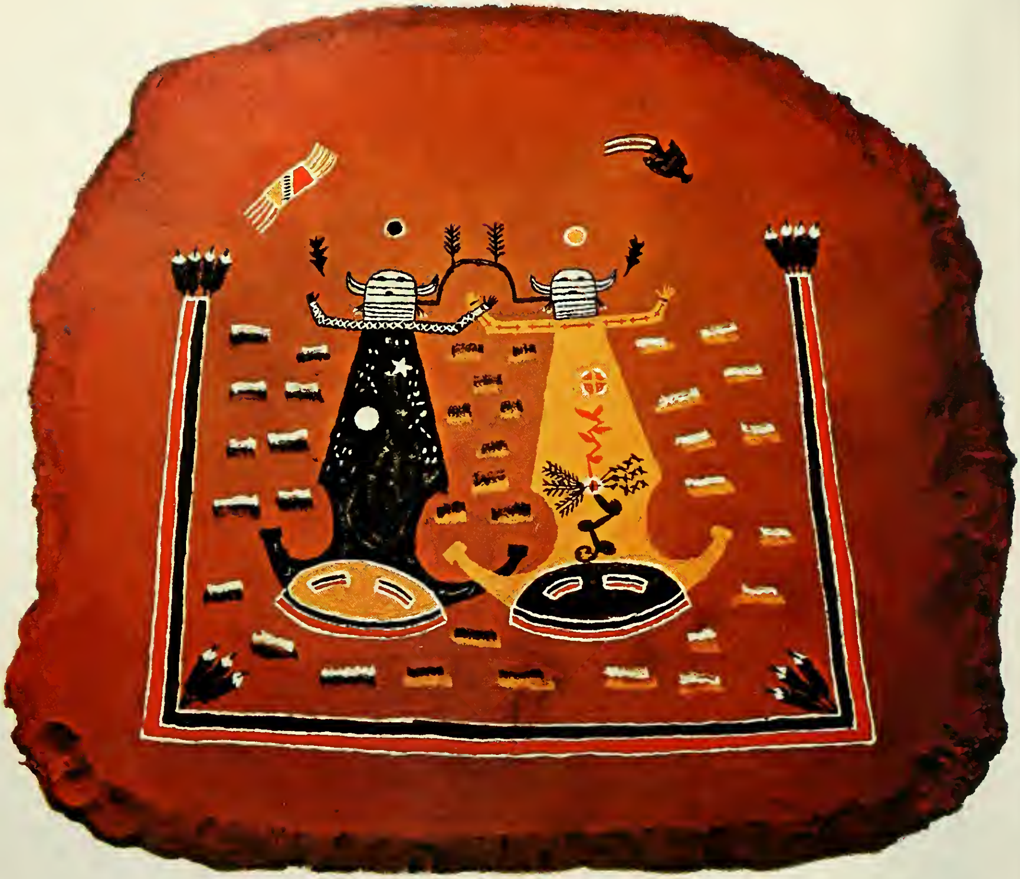

mother earth father sky navajo sandpainting artist: alfred dihyja

The earth can lose her resiliency. Her waters are polluted, her soil is becoming dust, some of her trees are poisoned. Someday she may be beyond her ability to heal herself. But what we do to her we do to ourselves.

The Indians call the earth their mother. We must protect the earth. We must learn to live in harmony with her; we must learn her moods and rhythms. We must love the earth.

The ideal
When man and nature are in harmony, the land is happy. There is great strength in this idea.

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Letters

Metamorphosis

Thank you for publishing Jecon Gregory's "Metamorphosis of the Monarch" (April, 1973). What a graceful combination of knowledge, personal observation, writing ability, and just plain charm on the part of the man and artist.

I wish he'd do children's books on this subject. Kids are inundated with so much slop—I think they would really appreciate him. I showed the article to four kids and nearly had to fight to keep it afterward. Little buggers wanted to rip it out and take it home!

Helen Hoover
New York, New York

Jecon Gregory's article was as quietly beautiful as his subject. Science and lyricism are quite compatible.

Mark Adkins
Columbia, South Carolina

The elementary nature of Jecon Gregory's article should have prompted you to investigate the accuracy of his observations.

A serious error is the discrepancy between the text entry for 9:00 A.M. June 8, which incorrectly states that "at first the wings are pleated, which is why only about a third of the wing showed through the chrysalis wall" and the corresponding drawing of the adult fore wing visible through the chrysalis wall correctly showing an entire wing in miniature—not a third of the wing. The wings of butterflies and moths do not unfold upon emergence—they expand.

Also, if the monarch drawn with outstretched wings is an illustration of the one the author observed emerging, he misdetermined its sex as female. Only males have scent glands, shown as the black dot on the upper side of each hind wing.

The protective coloration speculations of May 15 are "for the birds," and for the viceroy butterfly to "pretend that it, too, lives on milkweed" reeks with anthropomorphism. Since aphids (plant lice) are phytophagous, Mr. Gregory should not suspect one of having preyed upon a monarch larva (May 29).

Truth in nature is so amazing that resorting to fantasy or anthropomorphism is quite unnecessary, as well as inappropriate, for *Natural History*.

Robert T. Mitchell
Hyattsville, Maryland

View from the Burial Ground

Another contribution that cemeteries make to our contemporary problems might be added to the list provided by Jack Thomas and Ronald Dixon (March, 1973). It came to my attention in our town of Concord, Massachusetts, where cemeteries are situated within the business district and the separation of historical past and present reality often seems inconsequential. Coming upon an elderly Concordian who seemed transfixed by an example of youthful relaxation in one of the historic cemeteries, I inquired of him what he thought about it. I had expected to hear a sharp condemnation and was surprised by the reply. "It's a good use for the burying ground," he commented thoughtfully. "We've got to bridge the generation gap *somehow!*"

Edward S. Hodgson
Chairman, Department of Biology
Tufts University

While I usually enjoy your fine magazine, the article on "Cemetery Ecology" struck a very wrong chord in me.

I am not a deeply religious person, but I try to be considerate of people who are. Playing ball (of all things!) in a cemetery where mourners come is cruel and inconsiderate. Granted, cemeteries occupy lots of space in urban areas, but let's not cite "changing social attitudes" as being the reason for allowing recreation in them.

Respect the dignity of cemeteries as memorials to the deceased and pray that society finds better solutions to the urban recreation problem. Nothing is sacred anymore!

Lars E. Wiberg
Livonia, Michigan

Beleaguered Bison

Henry G. De Young's article on the bison (May, 1973) is rather disturbing. The people who want to kill 60 percent of the bison herd certainly lack imagination.

Mr. De Young states that 60 percent of the Yellowstone herd harbor *Brucella abortus*, but "seem to suffer little from it." Might it not be that those very bison harbor a gold mine of immunological information?

Who knows, perhaps some day ranchers will be happy about maintenance of buffalo herds to supply them with a *Brucella* vaccine less expensive than the existing one.

Robert A. de Forest
Sheridan, Oregon

Looking Down

After reading the article "Where Did You Go? Out. What Did You Find? Fossils" (May 1973), I was thoroughly amazed and excited that someone finally wrote down and recorded what I have been fascinated about for years. Now, I have proof for my peers that I'm not the only weird one who walks along looking at every crack in the sidewalk.

Good for you for publishing the article and for not being afraid of doing your own thing.

Ellen Johansen
Lindenhurst, New York

A Naturalist at Large

A Dog's World View

In the antics of a household pet
lie ancient patterns of behavior

by Kenneth D. Roeder

Shows in which animals perform like humans are universally popular. There is appeal in parrots that talk, bears that ride bicycles, kangaroos that box, and porpoises that play water polo. It is hard to say where this appeal lies; perhaps it tickles our egos to watch so-called dumb animals laboriously doing things that we can do with ease. Yet it is only natural that animals should seem to be "dumb" to us under these circumstances. One can imagine that we appear equally stupid to a dog if we try to follow the scent trail of game or to a porpoise if we clumsily swim underwater for a few seconds.

It is, however, more interesting to watch animals doing the things at which they excel and that have probably aided the survival of their species in evolution. Here we may be given a glimpse, however narrow, into their world and a chance to compare it with our own.

Watching wild animals suggests an African safari, but most people are limited to visits to zoos or circuses, where lack of space limits an animal's behavior. One solution is to observe a domesticated animal; this compromise even has certain advantages over the safari. Not only is it less expensive, but also a pet animal accepts us as a part of its life; our house is already a part of its environment, making it unnecessary to sit for hours in an uncomfortable blind watching an animal through binoculars. But this method also has serious pitfalls if we are using it to find out how an animal perceives its world and then relating this to actions that promoted the survival of its ancestors. A pet usually has been bred for many generations in association with humans and has also learned as an individual how to live with them. It is difficult to know what is "natural behavior" and what behavior the pet has learned from us or inherited from its domesticated ancestors.

One way of singling out natural behavior is to concentrate on those aspects of the pet's behavior that are unexpected or that seem irrational or bizarre to us as humans. These are the sort of actions that, if encountered in another human, would tempt us to ask "Why did you do that?" To get answers from a pet, however, we must frame our questions in the form of simple tests, which the animal is able to answer by its actions.

There are other sources of distortion in what a pet can tell us about its world. The experiments we carry out are, in themselves, likely to modify the pet's behavior. Learning is imposed on the naïve pattern that initially attracted our attention. At first, the pet may have acted to please itself, but later it may be trying to please us. There is also the possibility that the behavior in question is idiosyncratic, an individual quirk, and not a response to some ancestral urge.

Such thoughts as these suggested some casual observations on the bahavior of our dachshund, Morris. There is probably no other strain of *Canis familiaris* that has been more intensively selected by man, first as a working dog and later as a house pet. Yet Morris is immediately recognized as a member of the species by any other breed of dog. He makes the same acknowledgement, particularly to any bitch, irrespective of size, shape, or color. How does a dog identify doggishness as the common characteristic of a multitude of breeds? His criteria are not ours. This is part of a general question that I posed to Morris: how does a dog's world differ from ours?

KENNETH D. ROEDER

Some learned, and many not so learned, writings have examined this question. My own interrogation of Morris belongs to the latter category, being highly subjective, anecdotal, and nonstatistical. Perhaps I am merely describing Morris's idiosyncracies, but I have attempted to treat him as a fellow creature who lives in the same house, and I have tried not to demand that he become the simulacrum of a man. Of course, I have not fully succeeded in this, and Morris has learned a number of tricks and has made many concessions to human-style living.

Morris joined our household as a puppy. From the beginning he seemed to be housebroken and soon taught us to let him out by waiting at the door in a certain attitude. He seems to have had more difficulty in reaching an understanding with the Siamese cat, Max. Max and Morris made repeated and, I believe, mutually respectful attempts to read each other, but they never fully succeeded. Aside from some half-hearted sex play, their only known cooperative venture concerned a bottle of much coveted animal vitamin pills. One night Max knocked the bottle down from a high shelf, and Morris demolished the contents. After sharing the vitamin pills, Max took off for parts unknown.

Morris was just as curious as we were about Max's mysterious expeditions. Each time Max marched into the house and announced his return, Morris would systematically sniff him all over, first lightly on the mouth and ears, which Max could barely tolerate, and then intensively on each foot. Sometimes Max would return with a gift—a rabbit, field mouse, or chipmunk. The presentation was usually offhand, and the

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gift—often quite alive and apparently unharmed—would squeak or scuttle across the floor. I wish I knew whether Max enjoyed the uproar that followed as Morris joined in the chase to corner the quarry, but Max remained aloof and betrayed no sense of responsibility. Probably he was obeying some ancient urge to "bring home the bacon."

While Morris is somewhat rambunctious, he is completely amiable and no fool. After the usual number of puppyish demolitions, he showed a strict sense of personal property—his and ours. This sense of ownership is only underlined by his occasional transgressions, which can be traced to pique or disappointment at being left alone at home. Under these circumstances chewing our property could be considered an attempt on his part to train us.

Morris inclines toward rowdy games, mock biting, and rushing about. We soon gave him a ball, hoping to divert him from ourselves. When several soft rubber balls were quickly torn apart and eaten, we settled on a solid rubber kind about the size of a tennis ball. Inevitably, the inanimate ball was poor sport compared to the gifts imported by Max, and Morris would bring it to us to animate. In search of peace, we in turn would throw the ball as far away as possible. And so Morris's hobby, directed no doubt by his genes, became retrieving. I was soon curious about his peculiar technique of doing this.

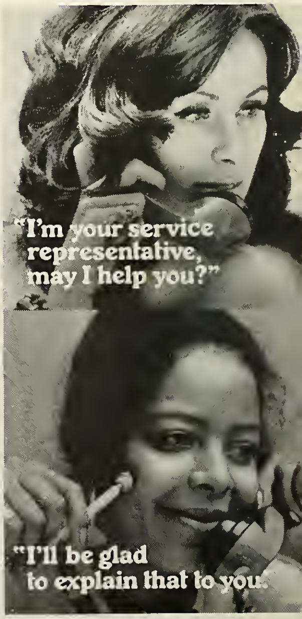
It must be emphasized that both Morris and I approached retrieving with equal naïveté. I am completely unfamiliar with the theory and practice of training hunting dogs to retrieve, and thus was unable and indeed unwilling to teach Morris anything about this art. Morris had only his senses and possibly some built-in instructions to help him. The resultant performance would probably reduce a professional dog trainer to tears.

At first, Morris seems to have been motivated merely to rush after the thrown ball. Later I believe that the ball's retrieval also became an end in itself. For my own part I must admit that initial unconcern soon gave way to a professional interest, for I am a student of sensory physiology, concerned particularly with insects, and have spent my life trying to learn how these simple creatures locate their mates, secure food, and avoid predators. I therefore observed Morris's performance with an inquiring, albeit subjective, eye.

The setting for these ball games is as follows: I sit on a wooden deck behind our house. In front of me is a flagstone walk. To the left there is a large maple tree; to the right, a clapboard wall. Between the tree trunk and the wall, a hundred feet of lawn—broken by flower beds—merges into low trees and bushes. As I attempt to read or to think Morris pushes his slimy red ball into my chair, whining in a particularly irritating fashion. I give in and fling the ball as far away as possible. I have found that the best way to achieve maximum distance is to bounce the ball hard on the rough flagstones in front of me; from there it takes a series of hops across the lawn and, if I am lucky, gets lost in the distant shrubs.

A trained retriever would undoubtedly find the ball as fast as Morris, but would then dutifully and promptly return with it directly to my chair. Morris's retrieval technique takes considerably longer but is much more interesting. Galloping after the ball, he visually follows and anticipates its line of flight, aided possibly by watching the movement of my arm. There are few directions in which I can throw the ball if I want to prevent Morris's onslaught across one of the flower beds. Thus, the game offers Morris little challenge unless the ball takes an unexpected hop on the flagstones and he loses visual contact. But first let us observe a routine retrieval in which the ball flies in an expected direction or else remains in view over most of its course.

Having picked up the ball, Morris begins to trot back toward the deck, his tail moving a little. After a dozen or so feet, he may or may not drop the ball. In either case, he begins to cast about, sniffing the ground and wagging his tail vigorously. He may run back to the point where the ball was first retrieved. Just as abruptly, he stops this hunting behavior, races back to the ball, and trots with it another stage nearer the deck. In the final stage he repeats these hunting and carrying maneuvers on the flagstone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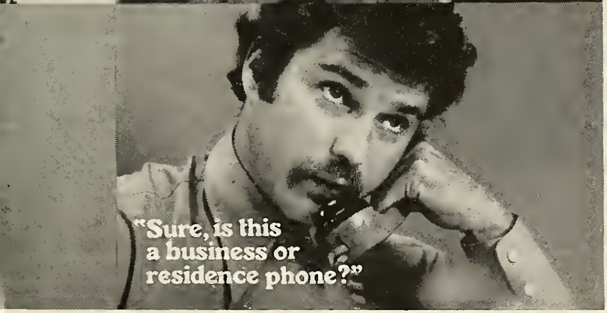
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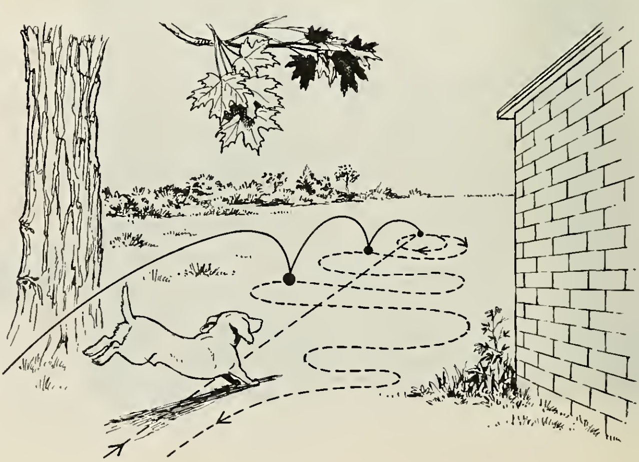
walk, where their intent becomes evident.

The first clue is that the soggy ball, from its first impact on the outward flight, sometimes leaves a moist patch on the flagstones. This enables me to note the point of impact, although the moisture has usually evaporated and the spot has become invisible by the time Morris returns to the walk with the ball. Here the casting about is repeated, usually, but not invariably, with ball in mouth, and Morris quarters the area, sniffing and snorting vigorously. As soon as he encounters the now invisible bounce point he pauses, sniffs for a moment, and then trots up with the ball to place it under my chair with an invitation for another throw.

This behavior suggests that Morris finds it essential to verify by smell in reverse order all the contacts made by the ball on its outward journey. Only when he has done this is he ready to return the ball to me. There are, of course, no marks visible to me at the bounce points on the lawn, although his sensitive nose is able to locate them easily. This verification procedure remains part of the retrieval routine, even though he has repeatedly seen or correctly anticipated the outward flight of the ball. Each contact point is sought and checked, often several times, during each retrieval. If I toss the ball high, so that it does not bounce until near the end of its course, Morris still searches for bounce points although he has seen the ball through most of its flight and has run immediately to the point where it dropped. Since intermediate markers are lacking in this case, the retrieval search may take longer than when the ball has bounced several times. Only when the ball has traveled less than a dozen feet does Morris retrieve it without verifying its path.

It is hard to know whether this curious verification behavior is idiosyncratic or whether Morris is obeying some dim instructions handed down from his ancestors. Its invariance and formality suggest the latter. But if this is so, I fail to see its adaptive value to a wild dog ancestor, assuming that tracking and retrieval in a domestic dog derive from hunting game and locating the pack in ancestral dogs. Having run down and captured prey or caught up with its fellows, why should a wild dog benefit from knowing where they came from? The only survival value that occurs to me is that this behavior may have once served to lead wild dogs from their captured prey back to their herds or mates or young.

As a sensory physiologist, I am also perplexed by the fact that Morris commonly carries the ball in his mouth while verifying its contacts with the ground. These olfactory traces must be quite faint, and one would expect them to be partially or even wholly masked by the original source in his mouth. This seems like expecting a person to detect faint traces of cigar smoke in a room while he puffs on a cigar in his mouth. It is noteworthy that



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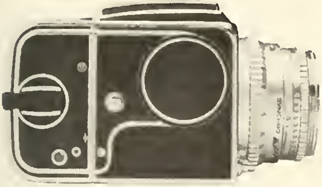

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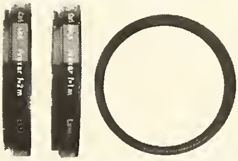
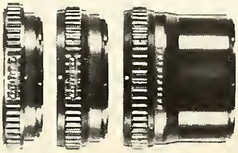


Carl Zeiss. Depending on the focal length of the basic lens, they can cover a wide range of areas down to about 8".



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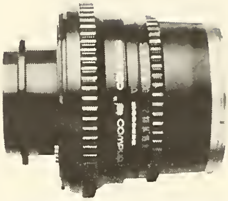

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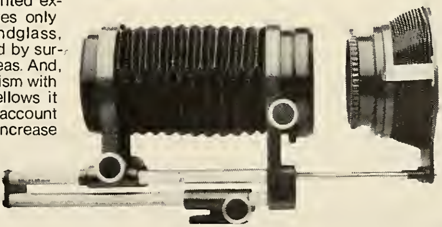

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Morris both snorts and sniffs while verifying, suggesting that air is inhaled through his nose and his mouth. Perhaps he is making a rapid series of brief comparisons of where-ball-is (air from his mouth) with where-ball-was (air inhaled through his nostrils), much as we might glance back and forth between two signatures while attempting to verify their identity.

I then became curious about the criteria Morris uses in making his verifications. They could be based on one or more of three different odors associated with the ball: Morris-odor, rubber-ball-odor, or thrower-odor. Idle attempts to solve this included pouring beer over the ball before throwing it, but this did not seem to confuse him. I then acquired a second rubber ball identical in appearance to the first and slightly nicked the surface of one ball so that I could distinguish them. Both lay around the house and garden for some weeks, and Morris would choose either one to bring to my chair to play the game of retrieval.

The game begins as before. Morris picks up a ball, let us say ball A, and importunes me to throw it. After he has made several retrievals, I covertly substitute and throw out ball B. Morris gallops as usual after ball B as it bounds across the lawn. When it rolls to a stop and Morris is about to seize it, he pauses, draws back slightly, and turns to look in my direction, his tail wagging gently. I make no response and he begins to hunt about, nose to the ground, tail sweeping vigorously. He casts about in directions that bear no relation to the ball's outward flight, frequently pausing to observe me. Some of these excursions bring him close to ball B, but he acts as if it did not exist. After quartering the lawn, he returns to my chair, his tail gently wagging, and sniffs around, acting as he does when I sometimes try to fool him by not throwing the ball at all.

In another version of this game, I gently toss ball A onto the lawn while he is still hunting and not observing me. When ball A is encountered he pounces and retrieves it with his usual verifications, leaving ball B where it landed.

I can only conclude that ball B, which he sees and chases on its outward flight, must seem for Morris to disappear as soon as he is close enough to sniff it. It ceases to be "his ball," that is, the ball I was expected to throw and that he recently returned to me. Ball-odor must be on both balls since they are interchangable when the game begins; since I have handled both, each must bear thrower-odor; the only difference is the lack of fresh Morris-odor on ball B, which has not recently been retrieved and mouthed.

The literature on animal behavior records many prodigious feats of animals tracking their food and mates by scent. For most animals, olfaction is a major means of orienting themselves to their world; for man, of course, with his poor sense of smell, this is not the case. One of the deodorant slogans, "Even your best friend won't tell you," implies that individuals are unaware of their personal scent, which has some physiological basis. The sense of smell, like that of vision or hearing, is subject to adaptation—that is, these senses become progressively less sensitive the longer they are continuously exposed to a given stimulus. They are useful mainly in detecting changes in stimulus strength or kind—a valuable property without which we might find our surroundings unbearable. It explains why we remain relatively insensitive to our personal odors, and enhances our appreciation of Morris's remarkable olfactory performance. Not only is he able to positively identify his personal odor, but he is also able to do this when it is present in minute and transitory traces left on the ground by an object he has mouthed some time previously.

To obtain some measure of the permanence of Morris-odor, I played variations of the two-ball game of retrieval. If he was encouraged to mouth both balls, he would retrieve either. When the balls were tossed out alternately, he would bring each back in turn. It takes Morris a minute or more for a retrieval, allowing time for his verifications, and I have the impression that he does not play the alternate-ball game with as much assurance as the single-ball game. If I withhold ball A while he makes two or three consecutive retrievals of ball B, his preference for ball B be-

Continued on page 84

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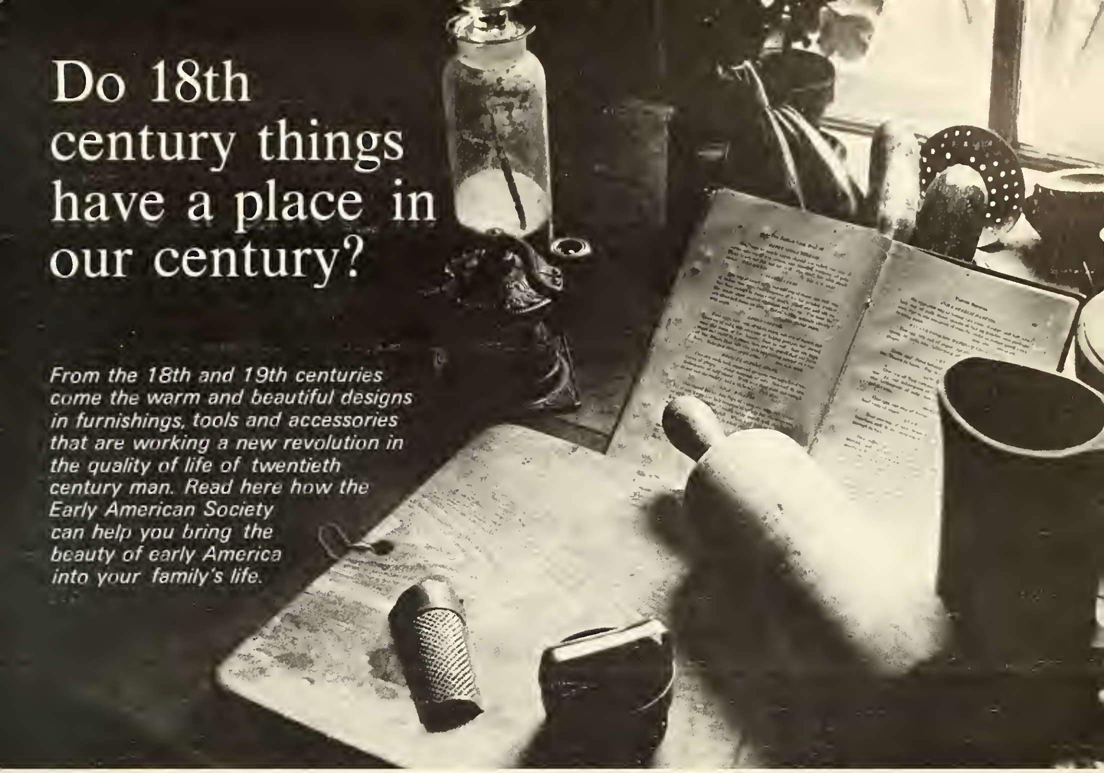

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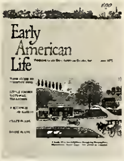

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The Rites of Summer

Circumambulate the city on a sunny afternoon and what do you see? In Herman Melville's day it was "thousands and thousands of mortal men fixed in ocean reveries." Far more abundant in our own times are the souls fixed in solar reveries—seminude men and women who crowd rooftops, parks, and beaches hopeful of a suntan.

As the history of the parasol indicates, civilized peoples have always considered it a privilege to be able to avoid the heat and glare of the sun's direct rays. Parasols were adopted with as much enthusiasm by the kings of West Africa as by the Chinese emperors and the popes of Rome. The kings of Siam even insisted on taking their multitiered parasols with them as they rode into battle on the backs of elephants. Everywhere ordinary mortals were forbidden to protect themselves with such devices, just as they were forbidden to wear silk clothing or carry swords.

The umbrella, incidentally, has always been the parasol's poor relation. To keep from getting wet, royalty mainly stayed indoors or inside enclosed vehicles. England's upper crust accepted the parasol long before they accepted the umbrella. They did not want to give the impression of not being able to afford a proper carriage.

By staying out of the sun, royalty—from Japan to Spain—kept itself several shades lighter than the peasants who worked in the fields. Where people's skin could be appreciably darkened by exposure to solar radiation—and this includes almost everyone of Asian and European descent—pallid skin became a mark of upper-class status. To be untanned was to be noble; to be noble was to be untanned. Also, since noble skin was pallid, the veins were more visible than in ordinary mortals; they looked bluer than the veins in the temples and wrists of peasants. And so there arose in Europe the notion of "blue blood."

The doctrine "white is beautiful" became an esthetic canon among the upper classes. Beautiful women were described by European court poets as having necks as "white as alabaster" or breasts "as white as snow." Members of the so-called yellow and brown races used the same metaphors of whiteness to characterize their own leisure class women.

In China, as far back as the Early Han period, 202 B.C. to A.D. 25, the nobility of both sexes used face powders made out of lead or glutinous rice and millet to enhance the impression of pallor. Suntanned European explorers arriving by sea in the eighteenth century were greeted, appropriately enough, as "red-faced barbarians" or "redskins."

In Japan, according to anthropologist Hiroshi Wagatsuma, the skin of the court ladies was described by the word *shiroi*, which is also the word used to denote the whiteness of snow or of paper. From A.D. 710 onward, white powder was applied to the face, cheeks were rouged, and teeth were blackened, creating an effect of stark pallor. During the Tokugawa period (1603–1867), women steamed their skin and then polished it with a cloth bag containing rice bran.

For many years after their initial contact with European explorers, Japanese artists painted Europeans with brown, gray, or pinkish faces. Japanese women appearing in the company of Europeans were always depicted in whiter shades than Caucasians.

Eventually, "whiteness" was internalized by the Eurasian lower classes and became their own ultimate psychological standard of beauty and excellence. This conformed to the normal process of diffusion of esthetic criteria downward from the upper classes. For, to paraphrase Thorstein Veblen, the tastes of the highest social or pecuniary strata usually determine what a community accepts as decent or honorific. It was in this way that the pink, brown, yellow, and red peoples of Europe and Asia acquired a prejudice against skins darker than their own.

In Europe, during the course of the nineteenth century, leisure class evaluations of suntans underwent a reversal. The change was closely correlated with the advance of industry and the decrease of agriculture. As the factory system spread, the upper classes developed an intense interest in the outdoor life; they began to cultivate vigorous, open-air sports such as tennis, polo, and mountain climbing. "Back to nature" became a favorite theme in literature and the arts. The man of action, bronzed by a tour of duty in India or Malaya, became the new paragon of leisure class male pulchritude, and the lithe, suntanned, tennis-playing, outdoor woman became a respectable alternative to the cloistered, snow-and-alabaster ideal of the old regimes.

Why did the suntan suddenly find favor? I think the underlying cause was in the reversal of the prevalence of sun and shade with respect to social class. With the spread of the factory system, the main locus of menial labor was moved indoors. A pallid complexion ceased to be the prerogative of the parasol-wielding blue bloods; it became instead the indelible mark of the men, women, and children whom Karl Marx described as capitalism's "wage slaves."

Industrialization made shade cheap and sunlight expensive. High-density urban settlements proliferated upward along narrow alleys, preventing sunlight from penetrating to ground level. Also, the industrial slums were characterized by high crime rates that made open-air diversions dangerous for working-class families. And most important perhaps, the high-density consumption of coal cast a permanent pall over working-class districts.

William F. Loomis of Brandeis University has shown that the permanent shadow produced by coal smog during the nineteenth century was the main reason for the epidemic of the crippling disease

by Marvin Harris

The bronzed look of today's sun-worshiping jet set would have been disparaged a century ago

known as rickets. Without exposure to ultraviolet radiation from the sun, the human body is incapable of synthesizing the hormone calciferol, which is released into the bloodstream by the skin and is essential for hardening calcium in growing bone.

The relative lack of the skin pigment melanin in European populations represents an evolutionary adaptation to the need for maximum exposure to weak and intermittent sunshine during the long northern winters. Tanning, on the other hand, is thought to be a protective device that mobilizes available melanin to screen out the more intense and potentially lethal radiation of the summer months. Incidentally, the blackest African skins are produced by precisely the same pigment, melanin, occurring in greater abundance in the epidermal layers, probably as an adaptation against overdoses of solar radiation in tropical latitudes. With industrial smog blotting out the sun, therefore, the European working class fell victim to rickets, especially during the winter.

Indoor confinement under crowded conditions was also associated with a higher incidence of tuberculosis among urban factory workers and their families. At the start of the twentieth century doctors began to prescribe "heliotherapy"—sunbathing—as a specific cure for this disease. So there was a definite health advantage to be gained by wealthy Europeans and Americans who embraced the outdoor life and elevated the esthetic value of suntan over that of pallor.

Nonetheless, a suntan as the new badge of leisure class identity should not be overlooked. Sunshine per se had nothing to do with curing tuberculosis and only a few minutes a day of ultraviolet radiation on translucent pink cheeks will keep the average pale-faced infant well supplied with calciferol, even during the winter months.

The intense mass irradiation that now goes on under the summer sun, however, is a definite menace to public health. In the words of Harold F. Blum of the National Cancer Institute, "an impressive amount of evidence converges to indicate sunlight as a cause of human skin cancer." This risk is greatest precisely among people of European descent whose skin contains the least amount of melanin. Contrary to popular expectations, the more one indulges in sunbathing, the greater

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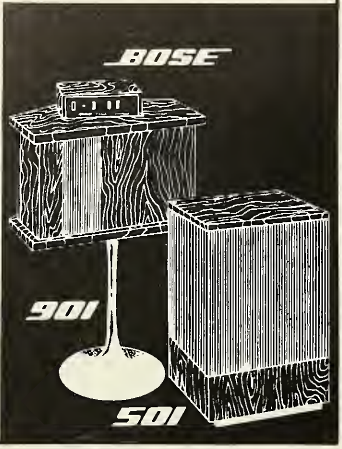

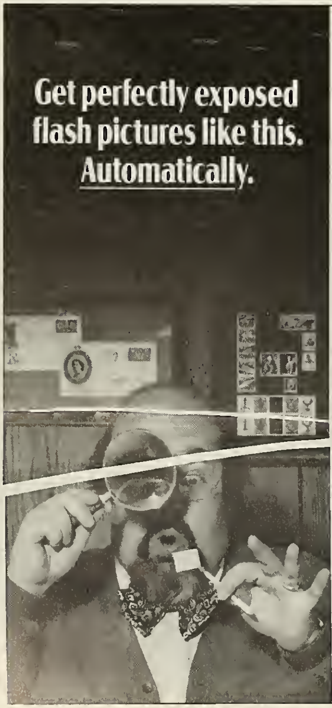
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the risk of developing skin cancer. A deep tan is the sign of a deeply injured skin.

At the moment, I see little prospect for moderating the cosmetic value attributed to the well-tanned face and body. The consumption of sunlight has grown into one of the major focuses of our economy. Under the influence of the tourist and real estate industries it has been democratized and no longer draws its main strength from the popular desire to emulate the superrich, who, I suspect, have once again begun to seek shade. In the arena of middle-class consumerism, keeping a year-round total body tan has replaced the Cadillac as a status symbol. For the average, pale-faced, installment plan vacationer, one conspicuous tan is worth a thousand picture postcards.

And what about all those sun-drenched condominiums whose investment value will plummet if people get around to thinking of them as cancer traps?

I do see one ray of hope in all of this—more people may eventually be forced to concede that color prejudice is for the birds.

Columnist Marvin Harris teaches anthropology at Columbia University.

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by Arthur W. Galston

Hard Times for American Science

The withdrawal of federal support for basic research will have adverse and far-reaching effects

The spirit of gloom that pervades American scientific circles is proliferating everywhere into a pessimistic outlook for the future. This persistent pessimism is spreading despite the unquestioned superiority of American science and technology in almost all fields, as evidenced by our great number of Nobel prizes, our leadership in space science, the advanced sophistication of our computer technology, and a scientific agriculture that has made us the major breadbasket of the world. The gloom derives, not from a loss of confidence in the continuing ability of American science and technology, but rather from recent decisions in Washington that will drastically alter the nature and extent of federal support of basic science and of the educational process that prepares young people to become scientists.

The federal government's massive support of American scientific development began during and immediately after World War II. In 1939–40, the highest annual expenditure for research in a university physics department was $39,000; during the war, expenditures went as high as $117 million for a single government contract to MIT. It is no exaggeration to say that science and technology made the difference between defeat and victory in that war; we need cite only radar, which saved Britain from the Luftwaffe, and the atomic bomb, which forced Japan's capitulation. By 1950, the Office of Scientific Research and Development, which had organized and guided much of the wartime scientific effort, had broadened into the National Science Foundation. Because of the Korean war the first NSF budget was only $225,000, but after Korea science began to get the kind of peacetime support in the United States that it had long enjoyed in other parts of the world. The National Institutes of Health greatly expanded their scope and budgets, facilitating a dramatic upsurge in experimental biology and medicine; the Atomic Energy Commission was empowered to bestow research grants for qualified experimentation in universities, research institutes, and industry; and the military, especially the navy, began to budget heavily for the support of basic science. Between 1962 and 1971 total annual research expenditures by government agencies ranged from $10 billion to $17 billion. Such support catapulted American science into the world's front rank and paid off handsomely in improved technology, health care, and productivity. It might be supposed that so successful a venture would automatically be extended into the indefinite future. Instead it seems in danger of being deliberately terminated. How could such a reversal come to pass?

To answer, let us first examine the process of funding for scientific research. I refer here to basic research: the investigation of new principles and generalizations, irrespective of their practical value. Applied, or developmental, research, by contrast, is concerned with the utilization of scientific discoveries for practical ends.

Most pure research in the United States is carried on in universities by professors and their graduate students, although industry and research institutes are constantly increasing their share. The average professor is reasonably well supported by his home institution in regard to his own salary. He is usually given adequate space in which to perform his research; in some instances, laboratory facilities are well equipped with the basic instruments required for the projected experimentation, but in other cases, the "laboratory" may consist of little more than four walls and a few tables. The most important limitation on a researcher's ability to proceed with his work, however, is that almost no university uses its own income to provide an individual faculty member with continuous support for research. (In the present financial crisis, subsidization from this source would, in fact, be impossible.) Consequently, an investigator has traditionally been expected to raise this money himself by applying to a national agency or private foundation.

The process works in the following way. Let us say that Professor X at Y University conceives of a new approach to the solution of an old and important problem in science. He prepares what is called a grant proposal, carefully describing the background of the problem, his objectives, some proposed experiments, and the significance of successful findings. He then estimates how long it will take to complete the project, what equipment and personnel will be required, and how much money the entire package will cost. After getting approval from the chairman of his department and an appropriate official of the university, he sends the application off to the appropriate agency in Washington. There, it is assigned to review or evaluation by a jury of the professor's scientific peers. If the proposal is judged scientifically meritorious, it is recommended for funding, sometimes, however, at a rate below that requested. If money is available, a grant is made to Y University for work to be done under the direction of Professor X. He then receives a budget from the university and is free to use the granted funds according to the terms spelled out by the agency.

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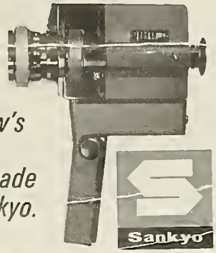

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forwards the individual's application to the federal agency, then receives and distributes the money granted. For these services, it exacts a fee, the so-called overhead. For example, at my university, overhead on a National Science Foundation grant is 66.67 percent of all salary and wage allotments of the grant; the excuse for taking so large a proportion is that all research creates expense for the university. Buildings must be maintained; water, electricity, gas, and telephones paid for; and service personnel such as secretaries, payroll clerks, janitors, and stockroom managers hired to attend to the needs of the researchers. The overhead requirement means that, on the average, the investigator has at his disposal little more than half of what he actually receives from the granting agency. Thus, if a grant is canceled, not only is the researcher unable to carry forward his work but the university is unable to maintain the accessory services that support it.

Why should the nation support such activities in the universities? One answer, of course, is that a flourishing scientific community supports the well-being of the nation's people. The generous funding of individual efforts in science through the grant system has produced a continuous flow of new findings that have catalyzed the development of ever improving medicines, machines, and techniques. This system is based on the belief that the creation of such a supportive milieu, giving researchers the opportunity to follow up every theory and discovery, provides the greatest potential for progress in the application of knowledge to man's needs, as well as the extension and preservation of that knowledge. Nourished in this milieu, science has been the wellspring of discoveries leading not only to the space program and television but also to the many peacetime uses of atomic energy, new synthetic fibers, fabrics, and plastics, transistors, computers, antibiotics, birth control pills, and new high-yielding strains of corn, rice, and wheat. And there is still much to be done.

Nevertheless, after two decades during which science enjoyed unprecedented support and freedom, Washington policy suffered a change of heart. Nineteen sixty-nine signaled a turning point. That year for the first time, funding for science did not increase, nor has it since, and in 1972–73, severe cutbacks defined a pattern whose consequences are already manifest. Many investigators in the midst of ongoing research are today receiving notification from the NIH that their proposals have been adjudged scientifically meritorious and recommended for funding, but because of the scarcity of money, their applications have been "administratively withdrawn." One typical result, of special interest to readers of *Natural History*, is that while the Russians and the Chinese have published extensive encyclopedias of their plant resources, our *Flora North America* project has been canceled. Against the backdrop of a highly touted "war on cancer and heart disease," the necessary basic biological research to accomplish those ends is being terminated. Similar examples could be supplied almost endlessly.

The most damaging effect is probably being experienced in the training of new personnel. For many years, the National Institutes of Health have administered a program of training grants, which helped support graduate students, medical and dental students, postdoctoral researchers, and faculty, thereby assuring the country of the continuing graduation of young people in sufficient quantity and quality to carry on basic research, improve industrial products, and pass on the traditions of science through teaching. This year, the administration has announced the phasing out of this program—no new grants will be funded, and existing grants will either be terminated at the end of this academic year or within a few years as existing fellows complete their graduate training.

Why should any public official, including the President, want to cut back a program that has served our country so well? After all, expenditure for the entire research effort in the United States represents less than 1 percent of the gross national product and has yielded value much greater than that. One successful research development alone, hybrid corn, has provided our government a greater financial return

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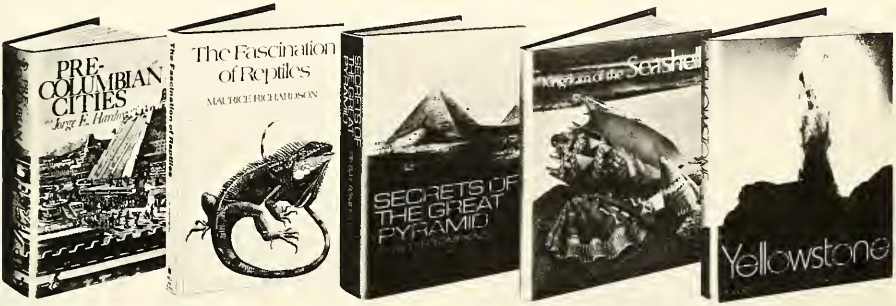

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than all the dollars it has ever spent in agricultural research, and a product like nylon has probably done the same for industry. Why, then, kill the goose that lays the golden eggs?

The answer is not simple, but one component of it is that federal administrators and legislators seem offended by the type of expenditure that is typical of basic research; they would rather mount massive research assaults on a single problem such as cancer or controlled thermonuclear fusion reactors. They are bothered by the allocation of small sums to many different, independent investigators working on a myriad of unconnected research ideas, many of them incomprehensible and even ludicrous sounding to the laymen, projects in which they cannot see the opportunity for immediate, dramatic results. They want a "bigger research bang for the buck," and believe that centralized planning and fiscal control will accomplish this end. To the academic researcher, widespread implementation of such a policy could be the death knell of basic science.

The hardest lesson for federal and industrial grant administrators to absorb is that undirected scientific research conducted by well-trained scientists constitutes the most practical and economical way to achieve scientific progress on a broad front. Many scientific discoveries are random and accidental, but they have a way of being made by extremely astute researchers. "Chance favors the prepared mind" was the way Louis Pasteur put it. Massive, coordinated campaigns can certainly be useful (for example, the war on polio and various parts of the Manhattan District atomic project), but they rest on the development of already discovered ideas rather than lead the search for new insights.

Federal administrators excuse the termination of training grants on the ground that there already are enough scientists and engineers; they cite the fact that even the existing ones are having trouble finding jobs. In view of such pressing problems as environmental degradation and the rising rates of certain diseases how can there be enough scientists and engineers? If science's full potential for alleviating societal problems were to be realized, many more scientists would be needed—even more than could be trained by expanding the present modest programs.

Thus, gloom in scientific circles is justified. Secure in the knowledge that science is an important aspect of man's endless inquiry about the universe and his own place in it, academic scientists see government funding as a most appropriate approach to this important intellectual end. This, together with the practical benefits accruing to society from widespread scientific research, constitutes an important rationale for the restoration of the recent damaging budget cuts. It is to be hoped that a second look at the benefits will encourage the federal government to reassess its current position and discover administrative devices to correct some of the ills observed in the present funding system without completely undermining the national scientific effort.

Columnist Arthur W. Galston teaches biology at Yale University.

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To Kill a Honeycreeper

A barrel of water brought from Mexico to Hawaii 147 years ago introduced an enemy that the beautiful native birds could not resist

Richard E. Warner

Before the advent of man, most plants and animals required the propulsion of winds and water currents or the ponderous drift of continents in order to colonize new areas far from their original ranges. A significant number of plants and a few invertebrates used migrating birds to bridge the barriers of distance, but for most life forms, geographical isolation—the physical separation of one place or population from another—was a major factor in their evolution.

The effects of such isolation upon the biotas of oceanic islands are striking. The likelihood of a continental organism successfully finding its way to a remote island is not great, the probability being roughly inversely proportional to the distance from its point of departure. The oceans act as great biogeographic filters, precluding passage to some, such as the larger mammals, and permitting that of others, such as certain birds, wind-borne insects, seeds, and spores. Once the journey has been made, the difficulties of colonizing a new land exacerbate the problem for would-be colonists. For each successful immigrant, perhaps thousands of would-be colonizers perish on arrival, finding the alien shores too hostile or beyond their range of adjustment. As a consequence, insular biotas generally comprise relatively few genotypes, with numerous endemic species. Vacant niches are common in such environments.

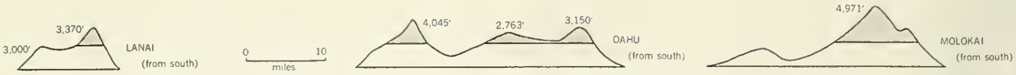
Having surmounted the enormous barrier of the Pacific Ocean, the vagabond life forms that reached the Hawaiian archipelago found an ecosystem containing myriad vacant niches. In the genial environment, with little competition from other inhabitants or foreign invaders, they speciated into diverse and often quite spectacular new forms over a period of 10 to 15 million years. Adaptive radiation, that evolutionary process where a single ancestral form is permuted into an array of new species, began operating in a highly favorable environment. Lobelias, diminutive plants on the mainland, diversified into small shrubs, large bushes, and even into treelike forms. Tarweed, whose mainland ancestor was also, no doubt, a small, shrublike perennial, adaptively radiated into an astonishing array of plant types. And the Hawaiian honeycreepers—small, colorful birds whose precise ancestry is still a matter of debate among systematists—evolved from a single colonizing species into a diverse array of forest dwellers that have been placed in a separate family, the Drepanididae, endemic to the Hawaiian Islands. They eventually became adapted to a wide variety of niches in the forest ecosystem, feeding upon nectar, fruits, berries, seeds, and insects.

Charles Darwin had marveled at the impressive array of plants and animals that had evolved through similar processes on the Galápagos Islands, an archipelago both younger and closer to a continental mainland than the Hawaiian Islands. Had he been able to walk through the primeval Hawaiian rain forests he would have been treated to a spectrum of bird forms even more dramatic and impressive than the *Geospiza* finches of the Galápagos, which so influenced his thinking on the processes of evolution. The subfamily comprising Darwin's finches, for example, contains four genera and some 12 species or subspecies. Responding to the multitude of vacant niches and the flow of evolutionary time, the Hawaiian honeycreepers evolved into nine genera with 18 full species and 39 subspecies, or readily recognizable island races.

Some were specialized nectar feeders; others fed primarily on nectar but also took some insects. Finch and parrotlike forms also developed. The now extinct mamo, *Drepanis pacifica*, had a long, deeply decurved bill adapted for feeding on the long, curved, tubular flowers of certain species of lobelias. Indeed, there is speculation that many of the highly nectarivorous honeycreeper species and many of the tubular-flowered lobelias evolved together. The Maui parrotbill, *Pseudonestor xan-*

Introduced to Hawaii in 1918, the Pekin nightingale has penetrated the remaining habitat of the honeycreepers.

RICHARD E. WARN



The surviving species of honeycreepers are confined to forests above the 3,000-foot level, shaded areas, above, although suitable habitat, right, still exists at lower elevations.

thophrys, whose heavy beak is used to crush bark and buds for insects, looks somewhat like a diminutive kea, an endemic New Zealand parrot. The extinct grosbeak finch, *Psittirostra kona*, had a massive, heavily muscled bill admirably suited for crushing the hard seeds of the naio tree, one of its principal foods. Early naturalists often located the bird by listening for the sounds it made while cracking open the dry seeds. Another group, the nukupuus of the genus *Hemignathus*, evolved bills and feeding habits that usurped the traditional woodpecker niche. The nukupuus are equipped with long, slender, decurved, or sickle-shaped, upper mandibles, while the lower mandibles are short, stout, and straight. These species use the heavy lower bill to chip away bark while searching for insects; after exposing a hidden grub or spider the upper bill is deployed to hook out the prey.

The primeval forest habitat of the honeycreepers was one of vast tracts of koa, *Acacia koa*, and ohia lehua, *Metrosideroa*, trees, which shaded a rich and varied understory of ferns, mosses, and low-growing plants in the wetter regions.

On the drier sides of the islands, other species of native trees adapted to a more arid existence. These forests, extending from the seashore to the high mountains, harbored populations of plants, insects, birds, and other creatures. Their long tenure in this isolated oceanic microcosm had been dominated by the phenomena of empty niches, lack of competition, incomplete intraisland isolation, and most important, geographical isolation from the continents with its attendant seclusion from the corrosive influences of technological man.

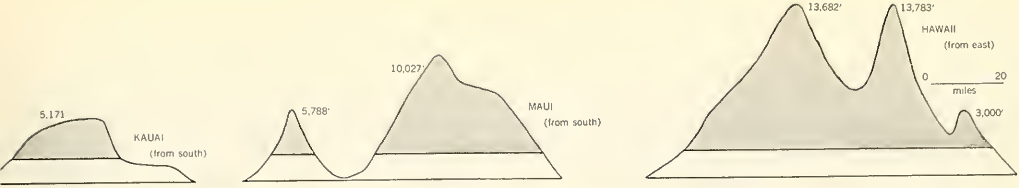
Gradually at first, then with dramatic abruptness, this idyllic situation was shattered. At about the time the Vikings were exploring the eastern shores of North America, Polynesians in canoes hewn from immense logs were striking out across the Pacific from the Marquesas and the Society Islands in search of new lands. As they hauled the prows of their canoes up onto the sandy beaches of the Hawaiian Islands, these courageous sailors constituted the first human breaching of that archipelago's long isolation. Fortunately, the impact of these first settlers was a gentle one.

The Polynesians brought with them pigs, dogs, rats, chickens, and several species of food plants. But because they lacked domestic herbivorous livestock (excepting the pig) or the technological capacity to mechanically ravage the land, they were assimilated into the island ecosystems with relative ease. They made their homes along the beaches and upon the lower slopes of the great volcanic mountains, exploited a few native plants, cleared a little land, and derived most of their food from the sea.

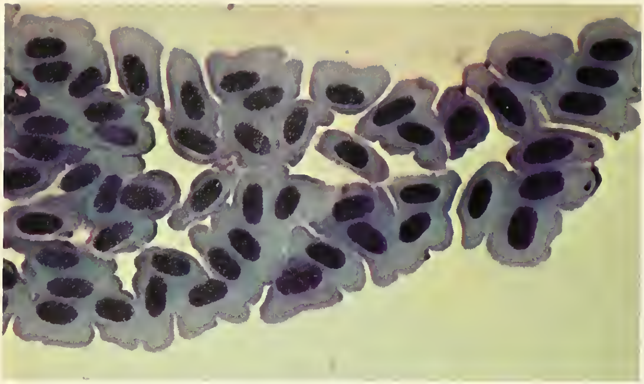
The discovery of the archipelago by Capt. James Cook and the crews of the ships *Resolution* and *Discovery* on January 18, 1778, however, was the beginning of the end for much of what was uniquely Hawaiian. During the next two centuries 75 percent of the native forests were indiscrimately destroyed by the white settlers who flocked to the islands. Sandy flats and watercourses became overgrown with the thorny kiawe, a giant Central American mesquite introduced as cattle fodder. The native vegetation of the flatland and foothill country back of the sandy beaches was replaced with a heavy gray green carpet of sugar cane and, in some areas, pineapple, and the higher hills were covered with nearly impenetrable thickets of introduced lantana, prickly pear, guava, and other exotics. Today, great barren gashes of exposed brick red earth scar many hillsides and canyon faces, the result of overgrazing by too many cattle, sheep, and goats. In many areas eucalyptus from Australia and silky oak grow cheek to jowl with the lower stands of the remaining koa trees. Considerable tracts of land have been converted to other forms of agriculture, such as macadamia nut orchards, or paved over in the construction of towns, cities, and highways for the burgeoning population.

Even the dark green rain forests—silent and brooding under the clouds that incessantly shroud the great peaks of Mauna Loa, Mauna Kea, Haleakala, Waialeale, and the other higher mountains—are in the process of slow and insidious change. Each year the exotic blackberry, fireweed, lantana, passion fruit, and other exotics press inward on the remaining native forest enclaves.

Goats had been brought to Hawaii in 1778, cattle and sheep were introduced in 1793, and horses in 1803. The descendants of this stock, gone feral and multiplying without control, created havoc in the more open and habitable upland forests. These herbivores killed off large areas of koa and mamane forest by destruction of the understory and direct feeding on the trees and their seedlings. For decades no attempt was made to control these feral populations, and even today they ravage the high forests on Hualalai, Mauna Kea, and Lanai, as well as portions of the Volcanoes and Haleakala National Parks, biotic sanctuaries where the native plants and animals are supposed to be afforded complete protection.


5,171
KAUAI
(from south)
5,788'
10,027'
MAUI
(from south)
13,682'
13,783'
HAWAII
(from east)
0
20
miles
3,000'

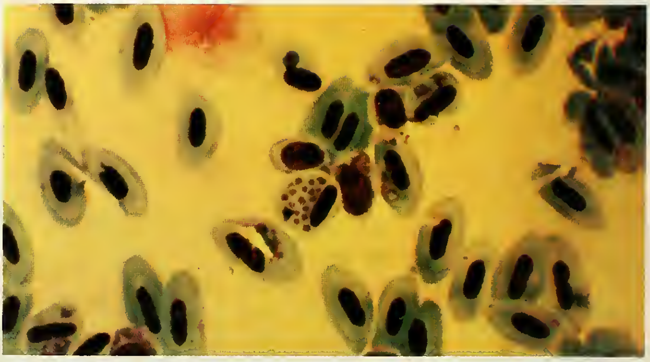
RICHARD E. WARNER



RICHARD E. WARNER

The iiwi, Vestiaria coccinea, *is one of the native Hawaiian birds threatened by avian malaria. The immature plumage of the juvenile, far right, will soon be replaced by the brilliant colors of the two adults.*

Normal red blood cells from a honeycreeper, above, are destroyed in great quantities by avian malaria, right. Shortly before death, the bird's blood is reduced to a pale color and a watery consistency.



Despite the acknowledged degradation of the great forests—whether from the sandalwood trade, which stripped the native woodlands of this species, the feral livestock, or the clearing for agriculture and the ever more frequent and intense fires—there was something subtler affecting the native birds, especially the Hawaiian honeycreepers. Like the Hawaiian people, whose pre-European population of more than 300,000 plummeted to a few thousand after the introduction of syphilis, measles, dysentery, and influenza, the honeycreepers experienced catastrophic declines shortly after the arrival of the white man.

It is true that many species of honeycreepers were highly adapted to feed upon native plants, a reasonable situation where the avifauna has had millions of years to adapt to the native vegetation. Despite the apparently high degree of specialization, however, many honeycreepers were able to successfully feed on introduced plants.

The ou, *Psittirostra psittacea,* for example, which normally fed upon the fruit of the native ieie, *Freycinetia arborea;* the mountain apple, *Eugenia malaccensis;* and the berries of various lobelias, also fed upon introduced guavas and mulberries. In 1902, the naturalist H.W. Henshaw recorded of the Hawaii amakihi, *Loxops virens:* "It has learned also that the imported nasturtium secretes a fine quality of honey and, however close to the house the flowers may grow, it pays them regular morning and evening visits." He also observed the amakihi regularly utilizing the blossoms of the introduced banana.

The rapid decline of the honeycreepers also could not be attributed to such introduced predators as the murid rats and the mongooses, although rats may have been responsible for the extinction of such ground-nesting birds as the flightless rails. Despite newly wrought ecological damage, many of the lowland native forests were still intact when the great die-off started, not having yet felt the influences of feral animals or modern technology.

No one knows for sure just when the decimation of the honeycreepers began, for in the early 1800s there were virtually no trained observers in the islands to document the decline. Some species of honeycreepers collected by the early explorers and colonists were present in collectible numbers for only a few decades after the arrival of white men, and it is only from a handful of skins in these very early collections that we know them at all.

By the late 1800s the enigmatic decline had become obvious through-

out the islands, in part because trained naturalists had observed the scene. Henshaw, who for several years had been prowling through the lowland rain forests, wrote:

> The author has lived in Hawaii only six years, but within this time large areas of forest, which are yet scarcely touched by the ax save on the edges and except for a few trails, have become almost absolute solitude. One may spend hours in them and not hear the note of a single native bird. Yet a few years ago these same areas were abundantly supplied with native birds, and the notes of the o-o, amakihi, iiwi, akakani, omao, elepaio, and others might have been heard on all sides. The ohia blossoms as freely as it used to and secretes abundant nectar for the iiwi, akakani, and amakihi. The ieie still fruits, and offers its crimson spike of seeds, as of old, to the ou. So far as the human eye can see, their old home offers to the birds practically all that it used to, but the birds themselves are no longer there.

This departure of the native birds from intact forests was not limited to a single island. On Oahu, for example, the endemics experienced an especially rapid decline. By 1900 six of the eleven native songbirds were believed to be extinct. The Oahu ou, *Psittirostra olivacea*, was among the species that vanished entirely during this period. It was known to be present on the island in 1893 and 1899, but was practically extinct by 1901. In 1915 the ornithologist W.A. Bryan commented: "Oahu can make the melancholy boast that it has a greater list of extinct birds, in proportion to the total number of species known from the island, than any other like area in the world."

Today, after more than a century of decimation, those Hawaiian honeycreeper species that have persisted are found only in the upland forests at elevations above 2,800 to 3,000 feet, and on the low, isolated, leeward islands of Nihoa and Laysan. The more wide-ranging and cosmopolitan species, such as the iiwi, apapane, and amakihi, still range over large areas of the higher forest on all the main islands. Others, such as the Kauai ou, the Maui parrotbill, and the crested honeycreeper are present in very small numbers and confined to limited tracts of relatively undisturbed, high-elevation native forest. The latter species, once found on both Molokai and Maui, is now extinct on Molokai.

The cause of the great decline in

RICHARD E. WARNER

numbers is clearly still present and acting on the remnant populations, but the principal culprit has now been identified.

At the time of its discovery by Europeans the Hawaiian archipelago was in many ways an insular paradise. Not only were the waters clear and filled with fish, the climate equable, and the women fascinated by the white-skinned strangers, but the beneficent islands were devoid of poisonous snakes, mosquitoes, and biting flies.

In 1826 this idyllic microcosm, already somewhat tarnished by diseased seamen, greedy opportunists, and miscellaneous do-gooders, experienced an event of profound significance to the native birds and of lasting annoyance to the islanders. For that year saw the introduction of the night-flying mosquito, *Culex pipiens fatigans,* to the island of Maui. A fierce biter of humans, *Culex* also feeds extensively on the blood of birds and is now known to be a principal vector of avian malaria and other blood pathogens.

Based on information from contemporary journals, F. J. Halford, in *Nine Doctors and God* (1954), chronicled the arrival of the mosquito:

> Dr. Judd was called upon to treat a hitherto unknown kind of itch, inflicted by a new kind of *nalo* (fly) described as "singing in the ear." The itch had first been reported early in 1827 by Hawaiians who lived near pools of standing water and along streams back of Lahaina [Maui]. To the Reverend William Richards, their descriptions of the flies suggested a pestiferous insect, from which heretofore the Islands were fortunately free. Inspection confirmed his fears. The mosquito had arrived!

Investigation back-tracked the trail to the previous year and the

The long, decurved bills of honeycreepers such as the iiwi, left, are adaptations for feeding upon the nectar of lobelias, top, and other flowers. Bromeliads, center, and geraniums, bottom, provide food for other species. Some endemic Hawaiian birds evolved large, heavily muscled bills suited for chipping away tree bark in search of insects and for crushing seeds.

ship *Wellington*, whose watering party had drained dregs alive with wrigglers into a pure stream, and thereby to blot one more blessing from the Hawaii that had been Eden. Apparently no attempt was made to isolate and destroy the hatchery, nor to prevent spread of the pest throughout the archipelago. The pioneer was *Culex quinquefasciatus* [*C. pipiens fatigans*], the night mosquito.

The *Wellington* had originally taken on water near the village of San Blas on the western coast of Mexico. Hence the mosquito larvae it carried in its water casks were those of the tropical subspecies *Culex pipiens fatigans*. Farther to the north, near Stockton, California, a temperate form, *C. pipiens pipiens*, replaces the tropical subspecies, being better adapted physiologically to live in the cooler northern latitudes. Had the *Wellington* filled its casks at Eureka, California, or at Portland, Oregon, the sequence of events that followed might have been much different.

The *Culex* mosquito is a hardy and versatile creature that breeds in ground water and is able to develop successfully in up to 30 percent seawater. This trait renders the numerous brackish coral potholes along the coastline accessible to it, permitting it to invade even the drier districts. It has a known flight range in excess of 14 miles, which facilitates its rapid spread once it is established in a new area.

The arrival of the mosquito provided avian malaria and bird pox viruses with a vector par excellence. Being active principally at night, *Culex* has little difficulty attacking sleeping birds, usually concentrating on those areas devoid of feathers, such as the feet, eyelids, lores, bend of wing, and legs. Cage studies that I have conducted on captive honeycreepers indicated that they are up to ten times more susceptible to being bitten by *Culex* than are such introduced birds as the white-eye. Probably because they evolved in the complete absence of mosquitoes, the honeycreepers normally do not crouch down on perches while sleeping or bury their faces into the back feathers as do most other birds. These habits leave them much more exposed to the attacks of the night-flying mosquito, by giving the insects ready access to the bare skin of feet, legs, and faces.

Studies have established that bird pox is also regularly transmitted by mosquitoes; the virus is

The warbler finch, Certhidea olivacea, *right, and cactus finch,* Geospiza scandens, *below, are two of the twelve highly specialized species and subspecies of the endemic subfamily of Darwin's finches, which evolved through adaptive radiation in the Galápagos Islands. In contrast, the Hawaiian honeycreepers adaptively radiated into eighteen species and thirty-nine subspecies, or island races.*

TUI A. DEROY

carried on the proboscis, or biting mouthparts, of the mosquito after it feeds on an infected bird. It has been established that the mosquito can transmit the virus for up to two months after feeding on an infected bird.

Because of ecological and physiological restrictions, the tropical subspecies of *Culex* is unable to colonize areas in the Hawaiian Islands at elevations above 3,000 feet. Extensive field studies on several of the high islands have clearly established that while *C. pipiens fatigans* abounds in the lowland regions, developing massive populations in the wetter areas, it is functionally absent at the higher elevations. Whatever the cause of this restriction to lowland regions, it most definitely is not the result of gross habitat change or the lack of breeding areas above 3,000 feet. There is no appreciable physical change of the habitat at, or immediately above, the mosquito/no mosquito demarkation line.

The effect of imported exotic diseases was evident to the naturalists witnessing the decline of the honeycreepers, and their accounts clearly indicate that such diseases were afflicting the native birds. The biologist R. C. L. Perkins, for example, wrote in 1903:

> Like many other Drepanididae the species of *Hemignathus* are grievously affected by a disease, which is probably con-

> tagious, and causes swellings on the legs and feet, as well as on the head at the base of the bill, and on the skin around the eyes. Sickly birds generally retire to dense cover to die, so that it is difficult to estimate whether the disease causes much mortality. I have no doubt it is sometimes fatal.

Others have provided similar descriptions of what appears to be bird pox virus infections in wild populations of Hawaiian honeycreepers.

Bird pox, or "bumblefoot" as it is sometimes called, was apparently not limited in its distribution. In addition to being reported on Kauai, Oahu, and Molokai, Perkins wrote of finding it in birds of the Kona district on Hawaii.

> As on Oahu, many of the birds in Kona had swellings on the legs and feet; in some cases they had even lost one or more claws and parts of the toes. The species affected were *Himatione, Hemignathus, Chasiempis, Loxioides*, and *Rhodocanthis*. It is probably, I think, the result of damp, as in almost every case the birds affected were those shot within the rain belt; while those above, even of the same species, were almost if not quite always free of it.

There is a profoundly significant element in this report, one which Perkins did not realize. He had observed that bumblefoot occurred chiefly, if not entirely, in the rainy lowland districts without recognizing the role of mosquitoes in transmitting the disease or the potential for transmission of other diseases, such as avian malaria, by mosquitoes. A search through the Hawaiian bird literature yields no mention of avian malaria because of the general ignorance of its nature and etiology during the period of the great decimation.

Adding to the difficulty of conclusively establishing avian malaria and bird pox, transmitted by the *Culex* mosquito, as a primary cause of the extermination of Hawaii's honeycreepers is that it has never, with one notable exception, been demonstrated in the blood of native bird species. Of well over a hundred honeycreepers from several islands whose blood has been examined for avian malaria, all (with one exception) were negative. The disease is today absent in the remnant populations of Hawaiian honeycreepers.

In order to postulate population decimation from avian malaria and bird pox, it was necessary to prove conclusively that these diseases are indeed pathogenic, and not just mildly so, but mortally virulent to Hawaiian honeycreepers. Studies had already shown that many continental passerine species are susceptible to both bird pox and avian malaria. But just as most humans recover from, and develop partial or complete immunity to, such contagious diseases as measles, many birds recover from bird pox and avian malaria.

To answer the questions in a more definitive way, a series of experiments was carried out over a period of several years on Maui, Oahu, and Kauai. One study was conducted to determine the impact of lowland exposure in a region of high mosquito populations. Thirty-six Laysan finches were taken directly from Laysan, which is still mosquito free, to Lihue, Kauai, where despite continued mosquito control measures by the State Department of Health, the high *Culex* population was a considerable nuisance to the residents. The birds were held in mosquito-proof quarters for one month, and all remained healthy. All blood smears were negative for avian malaria and no bird pox lesions were noted. After one month of this cloistered existence, half of the birds were moved outside during the night hours where they were held in large mesh cages that permitted ingress by mosquitoes. The other 18 finches were held in the mosquito-proof quarters.

In 16 days all of the finches exposed to night-flying mosquitoes were dead from massive cases of avian malaria. Blood smears showed that the exposed group had malarial parasites in up to 97 percent of their red blood cells. Red cell destruction was so great that the blood became pale and watery, with packed cell volumes (a measure of the quantity of cells per unit volume of blood achieved by centrifuging a thin tube filled with whole bird blood) dropping from the normal 53 percent to as low as 16 percent. This precipitous drop demonstrated massive blood cell destruction.

Having now established that the lowland Kauai malaria potential was great enough to cause massive mortality in at least one species of honeycreeper, a further test was undertaken to ascertain the magnitude of risk. Five of the previous control group were placed outside in large mesh cages for only three consecutive nights and brought in each morning. After the three nights of exposure they were returned to their mosquito-free quarters and held for observation. Seventeen days later three of the five birds were dead; the remaining two were listless and obviously very ill. Examination of peripheral blood smears indicated that all five of the exposed Laysan finches had contracted massive cases of avian malaria.

These results were augmented by an experiment using individuals from the remnant populations of high island honeycreepers. Eight birds of three species—amakihi, lesser amakihi, and apapane—were mist-netted in the high forest near Kokee, Kauai, at an elevation of about 4,100 feet. Field studies had previously determined that *Culex* was absent from this area, although it is found at lower elevations in the same mountain area. These birds, together with 22 specimens of the introduced white-eye, *Zosterops japonica* (cohabitants of the high forests that were captured at the same time), were transported to Lihue and held in tightly screened cages for one week. Blood smears from all birds, including the white-eyes, were negative for avian malaria. Packed cell volumes averaged a normal 53 to 54 percent. The birds appeared normal and healthy with no evidence of bird pox lesions or other debilities.

After one week, the eight honeycreepers and eleven of the twenty-

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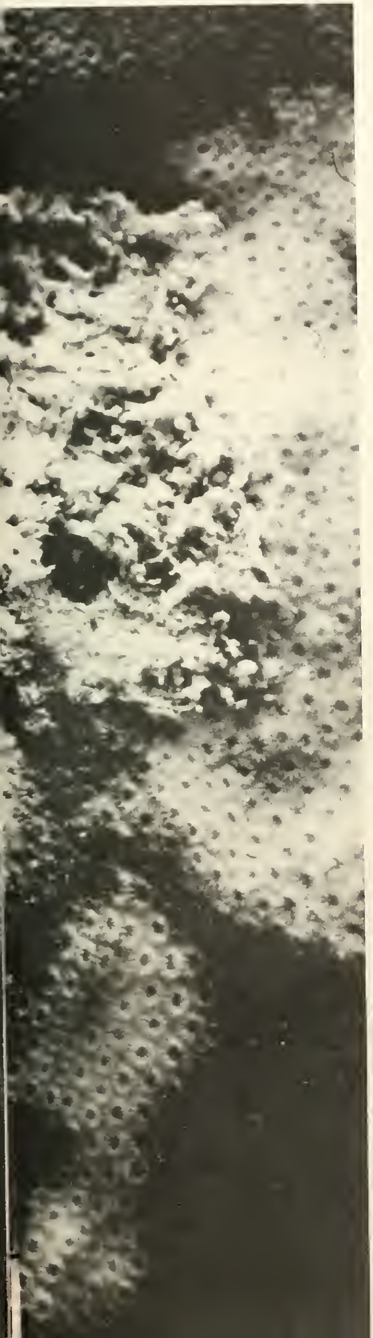
Sickness and Death

L. LEE PURKERSON

in Florida's Coral Reefs

Why do some corals thrive, while others turn into lifeless skeletons?

by Gilbert L. Voss



White spots on star coral at Ajax Reef indicate dead areas from which the living polyps are missing.

Florida's coral reefs are dying. Florida Keys conservationists claim that land developers' dredges are the cause. The developers indignantly reply that the amount of silt stirred up by their dredges is infinitesimal compared to that created by a single winter storm and point out that for a considerable part of the year the wind along the keys blows so strongly that sediments are naturally in suspension for long periods of time. Somewhere in between the conservationists and the developers are the marine biologists who are familiar with the reefs and agree that something is wrong with them but cannot pinpoint the cause.

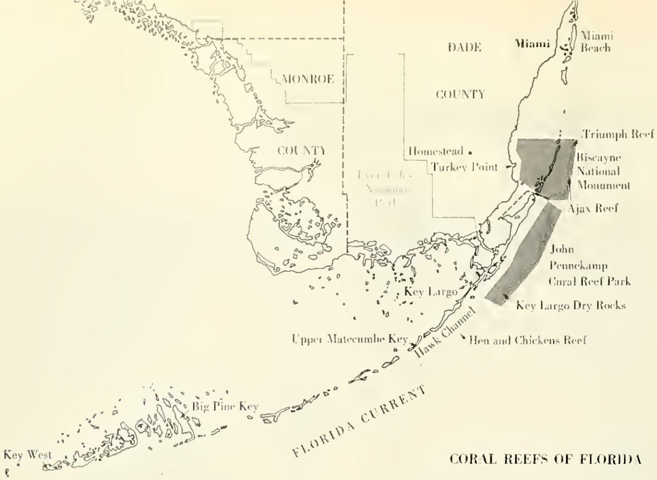
Regardless of who wins the controversy, the reefs, which are unique in the continental waters of the United States, are losing. In an attempt to save them, the state of Florida in 1971 imposed a moratorium—recently lifted—on all dredge and fill operations in the Florida Keys until their effect on the corals could be determined. Meanwhile, state and federal regulatory agencies look on with studied indifference. Only minor and inconclusive studies, lacking adequate experimental design and controls, are being undertaken. The developers continue to lobby in Tallahassee, the conservationists publish unsupported "evidence," and the biologists vainly write proposals for urgently needed research with little hope of getting funding from anyone.

The reefs of the Florida Keys stretch in a long, curving line from Fowey Rock near Miami to the little cluster of islands forming the Dry Tortugas, sixty-five miles west of Key West. On the seaward side they are bathed by the deep blue waters of the Florida Current, the mainspring of the Gulf Stream. On the landward side lie the greenish waters of the Hawk Channel, which separates the reefs from the keys. During high winds and their resultant surface turbulence, calcium carbonate in suspension turns the water in the lagoon behind the reefs milky white. During periods of calm weather the water is crystal clear or, as the natives describe it, "gin" clear.

From the deck of a boat or from the air, the outer, or barrier, reefs and the inner, or patch, reefs stand out clearly as yellowish patches in the variegated waters of the Hawk Channel. On closer viewing, however, the separate coral heads are seen to be covered with the waving purple plumes and fans of gorgonian, or soft, corals.

The barrier reefs, which form a narrow line at the edge of the platform on which they lie, are broken up by areas of white coral sand and beds of turtle grass. In some places they project above the surface at low tide.

Since Juan Ponce de León first skirted them in 1513, these reefs—bearing such names as Ajax, Pickles, Carysfort, Grecian Shoals, Alligator, American, and the Sambos—have been the graveyard of many ships. In stormy weather the sea's raging surf crashes down on them; in calm weather the yellow and cream branches of the staghorn and elkhorn corals form caverns and forests for hosts of brightly colored tropical reef fishes. Hurricanes tear great heads of coral loose and



CORAL REEFS OF FLORIDA

throw them over the reef flat into the Hawk Channel, but the scars heal in a few years, leaving no sign of nature's violence.

Patch reefs lie behind the barrier reef within the protected waters of the Hawk Channel, the keys' counterpart of a lagoon. The water here is seldom more than twenty feet deep, and the patches rise abruptly from the bottom to within two or three feet of the surface at low tide. These reefs are formed of massive, boulderlike corals, which may be single heads only a yard or two in diameter or large patches several hundred feet across. Around their bases, halos of white sand indicate the spots where parrot fish have grazed away the turtle grass. The tops of the patches are covered with various horny corals—purple, brown, and yellow sea whips, fans, and feathers—that sway and wave in the backwash of currents and waves, setting the whole surface of the reef in motion.

Coral reefs occur only in the tropical waters of the world, generally between 30° north and 30° south latitudes. A few, however, such as those in Bermuda, whose shores are bathed by the tropical waters of the Gulf Stream, lie outside this range. Non-reef-building corals live in cold water or in the ocean depths. Reef-building, or hermatypic, corals are physically distinguished from their smaller nonreef-forming, or ahermatypic, relatives by their massive or branched forms and rapid growth rates. The major biological difference between the two is the possession by the reef corals of symbiotic plantlike organisms called zooxanthellae. These algae live within the tissues of the coral polyps and give them their typical colors.

For many years biologists have puzzled over the role of zooxanthellae in the life of reef corals. Obviously the plants aid coral growth, perhaps assimilating such waste products of the polyps as carbon dioxide and, through photosynthesis, producing oxygen used by the corals. Because the corals are relieved of this work, some biologists suggest that the polyps are able to build more skeleton faster, thus forming coral reefs. Others dispute this theory. In carefully controlled experiments conducted at Discovery Bay, Jamaica, radioactive tracers were used to demonstrate that at least part of the role of the zooxanthellae is to act as a catalyst in the secretion of calcium carbonate during skeleton formation. The results did not however rule out the zooxanthellae's possible role in the basic metabolism of coral polyps.

Whatever the final picture may be, these tiny plants are essential to the life of the coral animal, and when deprived of them for long periods, corals die. This is one of the reasons why reef corals can only live near the surface of the sea in clear, nonturbid water where the plants can use sunlight for photosynthesis.

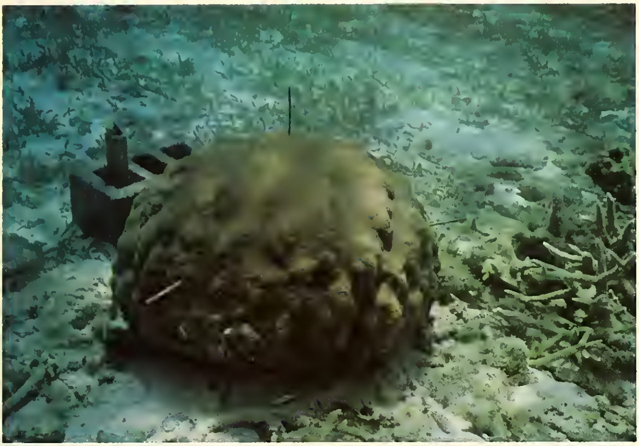
Reef corals also require warm, well-oxygenated ocean water for respiration and for catching plankton, the minute life upon which they feed. Since these water conditions are critical, corals only form reefs on the eastern sides of large land masses where the great ocean currents bathe them as they sweep by. Although most of their food is minuscule, some corals are able to catch and eat small fish several inches in length.

Corals grow quickly. Studies have shown that the branching forms can recover from the ravages of hurricanes within two or three years. Growth of the massive forms is not so spectacular because of their volume, but their over-all growth rate is as rapid as that of the branching forms. Thus, damage caused by ordinary storms is quickly repaired, and even limited, selective commercial coral collecting may not be too harmful.

One of the most important roles of coral reefs is providing a refuge for fish life. It was long thought that spearfishing would severely reduce reef fish populations; therefore sport fishing and conservation interests joined hands to prohibit it over much of the Florida Keys.

In an attempt to determine the facts a research team from the University of Miami's Rosenstiel School of Marine and Atmospheric Science did a study, beginning in 1962 and lasting several years, of fish populations in a section of patch reef at Margot Fish Shoal off Elliott Key. The results were startling. The reef contained far more fish than were in evidence from visual observation. Dozens of fish were taking refuge in the caverns inside the reef. Cooperative studies conducted by other investigators showed that the reef had a double occupancy and supported two populations: one at night, which feeds away from the reef during the day, and one during the day, which feeds away from the reef at night.

With carefully controlled capture of all of the fish from the study reef, the population structure and the numbers of species of fish were determined. The reef was resampled over a period of several years at progressively longer intervals, starting with one month and ending



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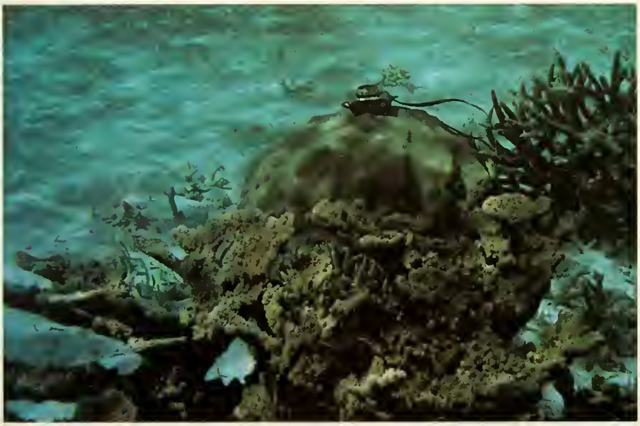


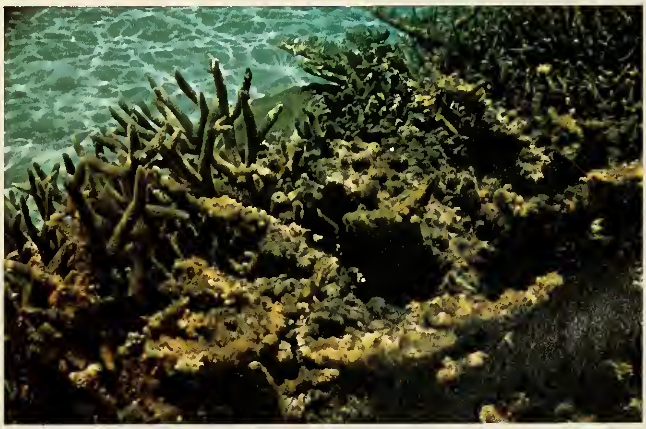
EUGENE A. SHINN

with a year. Analysis of the data showed that the small reef fish were highly territorial. When they were removed from the reef, the area was not recolonized from the surrounding reefs. Instead it remained barren until the vacant niches were filled by a new crop of fish. Even such large fish as the grouper and snapper did not return to normal levels until the next spawning season. Within a year, however, the experimental reef had reached its normal population level. The data also showed that migratory and large predatory fishes, such as barracuda and amberjack, that move about among the reefs were found in near normal numbers at the study reef within weeks of the first sampling.

Part of the research involved the construction of an artificial reef. In order to study its colonization, this man-made structure of quarried coral rock was placed among real patch reefs at a naturally occurring distance from them. To the surprise of the researchers, this reef base was not immediately overgrown by young coral and sea feathers. Although they did appear, for some unknown reason they also disappeared, and after more than ten years the artificial reef is still just a pile of boulders on the sea bottom.

During the 1960s and early 1970s, the population of Dade and Monroe counties grew rapidly. More and more people began to visit the reefs, some just to look, others to harvest coral, reef fishes,

The growth of healthy coral is recorded in these photographs taken over a ten-year period at the same spot in Key Largo Dry Rocks. In 1961, there was a solitary coral head, top. By 1965, a colony of elkhorn coral had developed, above. Six years later, a colony of staghorn coral had joined the elkhorn colony, at right.



EUGENE A. SHINN

and mollusks for the rapidly increasing tourist and tropical fish trades. Before long, the activity of these newcomers became visible on the outer and inner reefs.

Although not all coral and fish collectors strip the reefs, too many do. Tropical marine fish collectors often arrive at a reef in a fleet of boats, put on their diving gear, and fan out across the reef. Each collector is usually equipped with a small pry bar for turning rocks and a small dip net for catching fish. Divers advance steadily along the reef, turning old coral heads, slabs of coral rock, and other bottom structures, and dipping up the small, brightly colored fish as they go. Behind them, the overturned rocks, covered with encrusting animals and the eggs of fish and invertebrates, are eaten bare by schools of larger fish that follow the divers. A reef thus deprived of its nursery stock of mollusks, sea urchins, tunicates, and other life takes years to recover.

Collectors of elkhorn and staghorn corals often break off the branches with hammers or pry loose entire coral colonies, weighing many pounds, and hoist them onto barges. Treasure hunters searching in old wreck sites along Florida's outer reef sometimes use dynamite to blast the reef apart. Such methods of hunting and collecting can completely despoil an area.

It was to preserve at least part of the region around Key Largo Dry Rocks—a valuable national resource—that the John Pennekamp Coral Reef State Park was established in 1960. The creation of this park placed an extensive area of coral under protection. Conservationists hoped that this protection would save some of the best coral reefs in the keys from further damage. But man was still at work. In Dade County only the combined efforts of conservationists and biologists and a bitter struggle prevented the development of a major oil refinery and plastics complex that would have made it necessary to create a deepwater shipping channel through Florida Bay and out Caesar's Creek, across what is now the Biscayne National Monument.

Meanwhile the Florida Power and Light Company began construction of its Turkey Point nuclear power plant. Once again conservationists and biologists raised the alarm, pointing out that large amounts of heated effluent from the plant would endanger marine life in the bay. Under pressure from these groups construction of a cooling system of ponds and canals is under way. But the system is not yet completed, and heated water still flows into Card Sound and out into the Hawk Channel, where it may be contributing to a change in the nature of the coastal waters in which the corals live. While these activities are the most dramatic and easily seen threats to the reefs, the pressure of increasing population along the keys and northward may play an even more important role in the fate of the coral reefs.

The area from Palm Beach south to Miami is one of the fastest growing regions in the United States. About two million people now live in the area, a narrow strip of land about ten miles wide and sixty miles long. It is estimated that this population will rise to ten million in twenty years. The wastes of these residents must be disposed of, and in south Florida that means ocean dumping. In 1971, 120 million gallons of raw or partially treated sewage were dumped daily into the ocean between Palm Beach and Miami. At least some of this waste is carried to the reefs by southward-flowing inshore currents. Estuaries in the area were simultaneously being impaired by dredging, bulkheading, and industrial wastes. The result has been the rapid deterioration of south Florida's inshore waters. "Gin" clear only a few years ago, these waters are now opaque, yellowish green, or brown from eu-

Grunts swim through an inner reef in the Hawk Channel, where the warm water is shallow enough to let sunlight penetrate, a necessary condition for the growth of coral reefs.

BURTON MCNEELY

trophication or suspended nonliving material. As if the present situation were not almost too much for the sea to bear, developers all over the Florida coast and keys are rapidly turning coastal marsh and mangrove lands into housing developments and sites for giant condominiums in transactions involving vast amounts of money.

Coastal development in Dade County has almost reached the saturation point. Local government is being pressured to prohibit further high-density zoning and construction, and building moratoriums are being invoked. The situation in Monroe County is somewhat different. Much of the county is now occupied by Everglades National Park. Its remaining land is composed mainly of the keys. Those that are relatively high, such as Key Largo, Upper Matecumbe, and Big Pine Key, are rapidly being developed. Many of the islands, however, are mangrove-covered tidal lands and contain little dry land. They are now the subject of controversy in Monroe County. To be developed they must be filled. That involves dredging deep channels around them and constructing bulkheads. The process destroys the islands' valuable nursery areas of shallow-water turtle grass and removes the nutrient-supplying mangroves. The problem is further complicated by the type of bay or channel bottom sediments found in the keys. Formed mainly of calcium carbonate, the sediments are very fine, and when stirred up by dredging or wave action they remain suspended for hours or even days, turning the water milky white and reducing almost to zero the light penetration necessary for the health of delicate coral reef polyps.

Storms also create turbid water loaded with sediments, but reef corals are adapted to these conditions. After a storm the water clears up, giving the corals time to recover. Dredging doesn't offer this respite. If silt and turbidity are responsible for the death of corals, it may be because dredging operations interfere with the corals' natural ability to recuperate from the effect of storms. No one presently knows. Nor does anyone know whether death is caused by the inability of the corals to remove the silt from their surface or by insufficient sunlight for survival of the zooxanthellae.

In fact, it is not even certain that dredging is the cause of the problem. Other factors are also suspected. There is mounting concern that the illnesses of the reefs may be the result of increased loads of such chemicals as PCBs, pesticides, detergents, and heavy metals.

Biologists at the National Park Service claim that damage to the corals has already affected reefs in the Biscayne National Monument. They report seeing dead skeletons of sea feathers and fans on the reefs. They also saw corals covered with white spots—areas from which the living polyps are missing—on which patches of blue-green or filamentous algae were growing. These conditions may be due to man's interference with the reefs, but experienced ecologists know that similar conditions are found wherever reefs occur, even in the best of water conditions. The real question is not whether these natural conditions exist but whether the extent of white spotting and blue-green algal growth is increasing, indicating environmental deterioration. Informed divers state that the barrier reefs, surrounded by clear water, are in good shape, but that the inner patch reefs, more exposed to changes in coastal waters, appear to be affected. Unfortunately, no base line studies are available for comparison.

Concerning the condition reported for the Hen and Chickens Reef in the upper keys there is no controversy. This formerly healthy reef is now definitely sick, with most of its coral heads dead or seriously affected. Fish with body lesions, tail and fin rot, and shaggy, loose scales have been sighted there, as well as at Triumph and Ajax Reefs and in Pennekamp Park. Similarly diseased fish have been reported by divers and fishermen operating in highly polluted areas of the California coast and by workers at the Sandy Hook Marine Laboratory in New Jersey, who blame bacterial and viral infections from sewage dumped into the middle Atlantic Bight from the New York-New Jersey area.

When the John Pennekamp Coral Reef State Park was established in 1960 it was thought that the area it included would provide a safe refuge for the coral reefs. Among the regulations adopted for their protection were prohibitions on the collection of marine life, indiscriminate anchoring, and spearfishing. Recently a group of national and state park biologists met with scientists from the University of Miami to review the regulations in view of the deterioration of some of the better reefs in the park. The deterioration apparently was caused, not by ecological conditions, but by too much human use. If practicable, a rotation system controlling the volume of visitors may be initiated to give worn-out reefs time to recuperate. In order to study the effect of overuse, tracts are being set aside for controls along with counterparts open to the public. Comparative studies in the next few years may be very enlightening.

Several groups are now carrying out studies of small, discrete reef areas in an attempt to resolve the conflicting views of developers, conservationists, and biologists. But the problem is complex. Florida's coral reefs face serious trouble indeed—from unending sources of sediments, high turbidity, unprecedented amounts of sewage, partial eutrophication, disturbed current systems, thermal pollution, high levels of pesticides from south Florida's truck farms, and other factors. And there is no relief in sight. An unprejudiced observer might well be fearful that in the not too distant future our children may be able to learn about coral reefs only from books and documentary films, for one of nature's unique habitats will have vanished from the face of the earth. ☐

Hen and Chickens Reef attracts a school of dwarf herring. Once healthy, the reef is now reported to be almost 90 percent dead.

BURTON MCNEELY

PAUL [illegible] CONKLIN

Twilight of the Cree

A massive hydroelectric power project threatens to destroy the delicate relationship between these northern Indians and their bleak land

by Harvey A. Feit

The James Bay Cree Indians are an unusual people; 350 years after white men first entered James Bay in Quebec, the Cree continue to maintain the integrity and vitality of a hunting way of life. They live comfortably off the land in one of the less productive and least predictable environments of the earth, the subarctic boreal forest region.

Their hunting success is due in part to the knowledge the James Bay Cree have of their environment and, especially, of the animal populations on which they depend. Based on an intense relationship with the land, their expertise is extraordinary not only for the detail but also for the complexity of their observations. They manage the animal resources by observing ecological principles in deciding what, where, when, and how to hunt. They hunt so as to maximize the long-term stability of the resources, limiting their harvests to levels that can be sustained for many years; and they value this ecological goal over other economic, political, and social ends.

The Indian peoples of the eastern shore of James Bay, who have prob-

Hunting Nation

ably inhabited the region since the glaciers retreated several millennia ago, speak several local dialects of the Cree language. Collectively they have been called the James Bay, or the Eastern, Cree. The land on which they live was part of the unilateral grant by Charles II to the Hudson's Bay Company in 1670. It was transferred to the Dominion of Canada after confederation and is now claimed by the government of the Province of Quebec. The Cree, however, claim that they have never given up or abandoned their rights to this land.

This matter is now before the courts because the province is planning a massive hydroelectric project that calls for the eventual damming up of seven rivers and the creation of reservoirs. All of the rivers flow through the subarctic boreal forest and the tundra of eastern Quebec, an area of 172,000 square miles. Five of the rivers empty into James Bay, one into Hudson Bay, and one into Ungava Bay to the north. With the reservoirs will also come the inevitable roads, airports, towns, and more white men. No one is quite sure how these developments will affect the ecology of the area—flatland, fragmented by thousands of lakes and hundreds of rivers—but the Cree are fearful that the land—as they have known it for thousands of years—and their relationship to it will be forever changed for the worse.

The Indians, numbering approximately 6,000 people at the end of 1972, are organized into eight administrative bands: the Mistassini, Waswanipi, Nemiscau, Rupert House, Old Factory, Eastmain, Fort George, and Great Whale River. The Waswanipi, distributed in a number of settlements between the

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towns of Mattagami and Chapais about three hundred miles northwest of Montreal, and the Mistassini are the only inland bands—the others hunt inland but their settlements are located along the bay.

As recently as twenty years ago the settlements of the James Bay Cree were little more than trading posts and summer gathering places for the respective bands between hunting and fishing expeditions. Most of the whites in the settlements provided services for the Indians, except in the area of the southern mining towns of Mattagami, Chapais, and Chibougamau. In 1971, the estimated white population of the entire region north of these towns was 350 persons, mainly government agents, teachers, medical staff, fur traders, missionaries, and bush transportation personnel.

In the last two decades, however, government assistance and wage employment have become available, and Indian children have started going to schools. These are the most recent of a long series of changes brought about by each successive wave of whites—first the fur traders, then the missionaries, and now the government agents. Each wave has, in turn, been accepted by the Cree provided it assisted them to maintain their culture.

The Cree have generally felt that, along with knowing their own culture, it was important for their young people to be educated in schools. But even government assistance and schooling have not brought integration into the Canadian mainstream, and the Cree have increasingly sought Indian curricula and staff. Furthermore, to teach their children Cree ways and

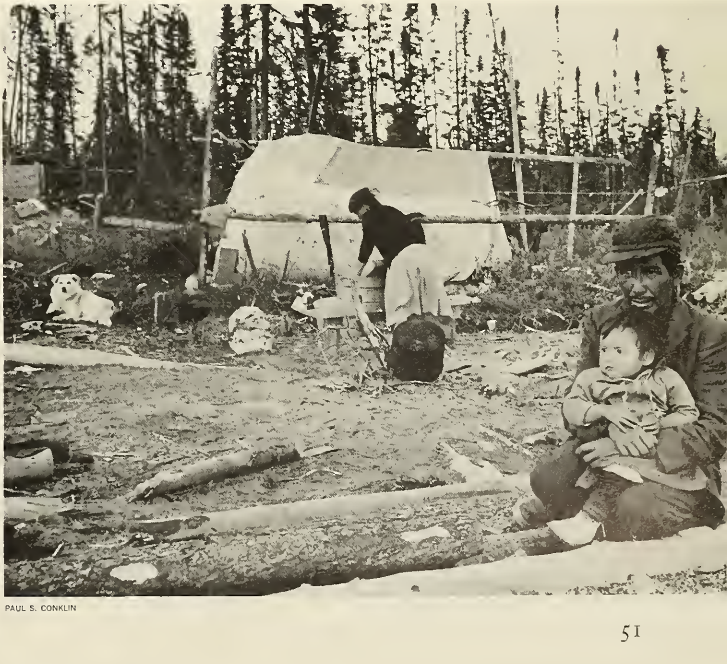
thereby prevent their total alienation from their own language and life-style, the Cree keep approximately one-third of the school-age population out of school each year.

Wage employment has been integrated with a hunting life-style in a number of ways. At inland settlements such as Mistassini, summer wage employment is combined with winter hunting and trapping. The Cree choose jobs that are compatible with their social organization, bush skills, linguistic preferences, and seasonal changes. Commercial fishing and cutting forests for pulpwood are jobs that can be performed by family work groups, at irregular times, and in the bush so that fishing and hunting can also be carried on daily. In Waswanipi settlements, intermittent work and hunting have become common.

Most members of the Fort George Band live and work in their settlement year-round. Fishnets and snares are set within several miles of the settlement and checked every few days by family members. On hunting and trapping trips, men use snowmobiles to travel up to 100 miles. The Fort George settlement, the most diminished in bush living of the coastal bands, depends on the land for approximately one-half of its annual food requirements and the majority of the protein it consumes. For the James Bay Cree as a whole it has been estimated that 50 to 60 per cent of the food consumed is produced by subsistence activities. As a result of the successful integration of wage employment and education into their way of life, the Cree are developing closer ties to the society and economy of the rest of North America, while maintaining and modernizing their hunting way of life.

The hunting, whether full-time or part-time, still follows a cycle determined by the animals and the land, but it is only the full-time hunters who disperse each fall from the settlements for the winter hunting and trapping season, which lasts from five to nine months.

Throughout the winter hunting season the Cree are widely dispersed over 124,000 square miles of the James Bay region. This area is formally divided into parts that are used by each band and further subdivided into 233 hunting territories, or trap lines, ranging in size from approximately 100 to 1,500



In summer, some families move from cabins to cooler tents, which are often situated near logging sites. The Indians work at cutting and peeling pulp logs that are bought by paper companies.

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square miles, occupied by hunting groups. Hunting groups are made up of from five to thirty persons. Based on bilateral kinship ties and friendship bonds, each hunting group forms a separate, self-sufficient residential unit whose members live together from September or October until they return to the settlements in March or June. The hunting territories are recognized as part of the government's beaver preserve system. Each territory is "owned" by an individual, who is usually the leader of the group using the territory as well as the beaver tallyman.

As modern hunters and trappers, the Cree frequently fly between their settlements and their camps in chartered bush airplanes; at the camps they use canvas-covered canoes, outboard motors, and sometimes snowmobiles for transportation. They also use rifles, shotguns, steel traps, factory made fishnets and canvas tents, tin woodburning stoves, and commercially manufactured clothing. But they prepare their own caribou, moose, and beaver hides, using fleshing tools and other implements that they have made: make their own snowshoes, toboggans, moccasins, mitts, and sealskin mukluks in the coastal settlements; and build their own lodges and camps.

The animals available in winter vary from region to region. In the southern areas at Waswanipi and neighboring portions of Mistassini, winter subsistence depends primarily on moose and beaver. In the inland north, caribou are as important as moose and beaver; while on the coast, fish and preserved geese are important. At various times and places secondary winter resources include hares, bears, porcupines, ptarmigans, and partridge.

While on their hunting territories, the Cree provide the majority of the food they consume. At Waswanipi more than 82 percent of the food is caught in the bush. Thirty percent of the calories available in winter come from moose. The average weight of moose killed is estimated to be more than 600 pounds, providing an average of 330 pounds of meat, fat, and edible organs per animal. Beaver, averaging just under 13 pounds of meat and fat per animal, provide 34 per-

Some cabins, such as this one owned by a Mistassini Band family, were financed by the federal Department of Indian Affairs. Women and children are left behind in the settlements when the men are off hunting.

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cent of the calories. Averaged over the whole year, fish are an equally important source of food. The few estimates of nutritional requirements indicate that all groups living on the hunting territories catch ample supplies for their needs, and many catch a surplus, some as much as two or three times their nutritional requirements. This food is made available to those residing in the settlements.

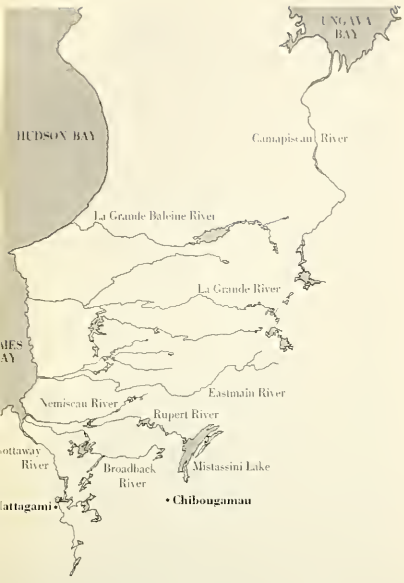
The view that hunters kill when they can and go hungry when they cannot is common in both popular and scientific opinion. Big mammal hunting especially has been characterized as unpredictable, unreliable, and inefficient because the animals themselves are widely dispersed and highly mobile. Cree hunters, however, do not share this assessment; they speak of big game hunting as a reliable, efficient, and productive means of subsistence. The evidence I gathered during a two-year study of the Waswanipi Cree confirms the hunters' views. As I accepted this view rather reluctantly, it is appropriate to recount the research findings. In a general sense, the principles of management and the organizational techniques used by the Waswanipi are probably typical of the James Bay Cree, although confirmation of this must await more intensive studies of other groups.

Moose in particular have been considered highly erratic, nongregarious, wide-ranging animals that can be hunted only with considerable uncertainty. The Waswanipi hunters stress, however, that killing a moose is easy. I was consistently told that when they are hunting moose, they are happy when they see tracks because they know they will soon be eating moose. When I asked the hunters what they did when they did not locate moose on a given day, they said they looked again. But when I questioned them as to what they did when they could not locate any moose, I was told that this never happened.

The Waswanipi say they know how to kill moose at any time of the year, but they generally limit their kills to specific seasonal periods and to specific daily climatic conditions within these seasons. During the mating season in October, the male moose can be called with a birch bark caller to the shore of a river or lake where they are easily exposed to the hunters.

Moose hunting is also productive during the latter part of March and early April, late winter in this region, when sunlight melts the topmost layer of the snow, which then freezes during the night. In the mornings or on colder days moose will break through the ice, cutting their legs against the edges of the hole. Under these conditions they often will not move, even when in full view of a man. Kills, however, are limited at these times because in the fall many hunters have not yet gone to their hunting grounds, and in the late winter many are preparing to return to the summer settlements.

The most important moose-hunting period for the Waswanipi is in January and February. During the early winter, the moose begin to have trouble walking as their legs penetrate deeply through the light fluffy snow and their bodies drag. The critical snow depth for an adult moose is two and a half or three



feet—beyond this the moose must plow a trough in order to walk. Throughout the early winter, therefore, moose move to locations with lower snow accumulations. Waswanipi hunters say that the moose move to hardwood-covered hills exposed to the wind, which blows the snow cover thin.

By January the moose are usually concentrated in these suitable areas, generally confining themselves to established paths they have packed by repeated use.

When this happens, hunters say that moose can be easily stalked. If a moose sees or, more likely, hears a hunter, it will flee from its "yard" only to be quickly exhausted by the deep snow. The Waswanipi report that after a few hours of steady stalking, a man on snowshoes will have so tired a moose that it will stand its ground and be killed.

Hunting is preferred on so-called moose days, when there is a slight north or west wind, a light snowfall, and a moderately cold temperature. The sound of the wind covers the noise of the hunter's approach, the snow allows the age of tracks to be easily judged, and the moderate cold keeps the snow fluffy and dry so it does not make noise or stick to the snowshoes and make walking difficult. If the wind is from the east, however, the moose will stay hidden in deep bush, making them difficult to locate.

The Waswanipi prefer to hunt for moose at those times when the chances of success are high. The hunters stress that it is important that they kill moose and other animals swiftly and cleanly. They say that moose meat is less tasty if the animal has been exhausted before being killed, and more important, they must not make the animals suffer unnecessarily.

In the culturally constructed world of the Cree, the animals, the winds, and many other phenomena are thought of as being "like persons" in that they act intelligently, are willfully idiosyncratic, and understand, and are understood by, men.

The hunters say that the animals they kill are a gift to them from the animals themselves and from the master of the animals—*Chuetenshu*, the north wind, who is the helper of Jesus. *Chuetenshu* brings the cold, the snows of winter, and his little brother, the west wind. The gifts given to a hunter place him under reciprocal obligations to cause the animals no unnecessary suffering, to observe structured procedures for retrieving, butchering, and disposing of the animal, and to completely use the flesh and useful parts. The animal's body nourishes a hunter and his family, but the animal's soul returns to be reborn, so that when men and animals are in balance the animals are killed but not diminished, and both men and animals survive.

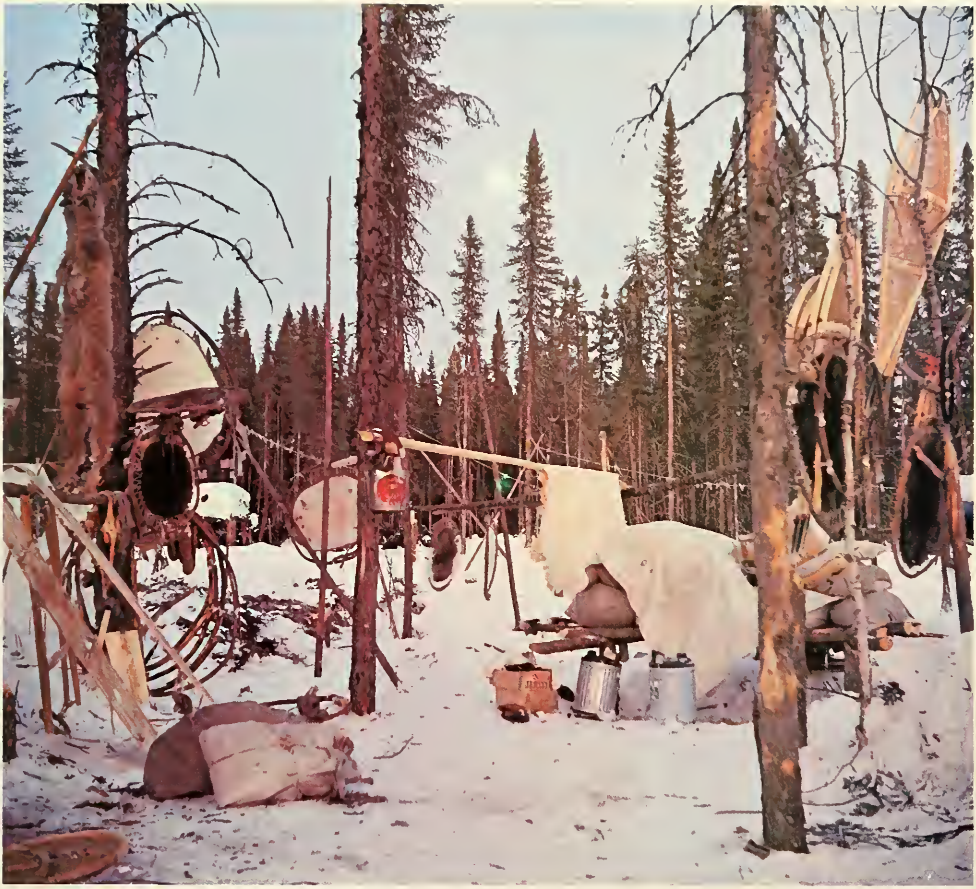
An analysis of Waswanipi moose-hunting behavior indicates that their actual hunting is consistent with their descriptions. In a sample of midwinter moose hunting, all kills occurred after the snow cover was more than thirty inches, 75 percent of these occurred on days with a snowfall of one inch or less, and the same percentage occurred on days with above average wind speeds. One kill was made for approximately every two days' hunting effort.

Waswanipi reliability and efficiency is also evident in the hunting of other animal species, which are harvested when chances of success and the efficiency of capture are high. The annual cycle is a model for integrating these various harvesting activities so that each is used at the appropriate time, and so that at least two resources can be used at each period throughout the year.

The Waswanipi are such successful hunters that their most critical problem is, not the locating and killing of game, but rather limiting the kills that their prodigious skills make possible. If the hunters were to kill more animals than are being produced by the species population, future production might then be reduced. This problem is especially critical in a zone of relatively low biological productivity.

The Waswanipi recognize that the hunters must balance their kills. While the animals a hunter kills are gifts from *Chuetenshu*, one of the obligations a hunter must fulfill is to determine which of the animals he encounters is being given to him. This decision depends on integrating information from a variety of sources—signs of the animals, weather conditions, the behavior of the animals, dreams and visions, and the hunter's past success. Each of these pieces of information is thought to be a communication from *Chuetenshu*, the animals, or other personages involved in the hunt. The most general informational frame within which this data is placed is the hunter's own previous hunting success.

The belief is that if a hunter should kill more animals than he was given in any year, then *Chuetenshu* and the animals will be angry and will give that hunter fewer animals the next year. The success of past hunting and its implications for current hunting are communicated to the hunter by the animal signs he sees. Hunters constantly note signs of the frequency of game and compare their evaluations of the trends in the animal populations. These trends are the most important indicator for a hunter of what he will be given in the present season, and through them most hunters formulate a definite expectation.



PAUL BAICH

Animal pelts in a Mistassini hunting camp, above, are hung to dry out of reach of dogs. The pelts are purchased by fur traders who fly from camp to camp in bush planes. At right, moose meat is hauled from the site of the kill to a camp, where it will be stored until taken to the settlements.

BOYCE RICHARDSON

Until the coming of the snowmobile, Cree settlements were partially deserted during the winter when hunting groups went off to their hunting territories. Now the hunters can return to the settlements after brief expeditions

PETER S. SINDELL

At the beginning of each hunting season most Cree dream or are told by *Chuetenshu* how much big game they will be given. This information is constantly checked and revised as the season progresses. The result is that the hunters feel themselves under an obligation to limit kills to those animals they know are harvestable without initiating a decline in the population.

Deciding how many of each species should be killed is an extremely complex task; one of the ways the hunters resolve it is by rotational use of the hunting territories. Families with few active hunters and dependents relative to the size of their territory hunt only a portion of the territory each year. This way the Cree hunt moose and beaver intensively on one section in a given year and then monitor the growth of the populations on that section in the succeeding years.

Rotational use allows the hunters to live off the most efficiently usable and most highly valued food species, namely moose and beaver. An analysis of the catches indicates that under rotation, harvests are well below the productivity of these species.

Those families who, because of the small size of their hunting territories or the large number of hunters and family dependents, must use all of their territories each year, face a more difficult problem. Fish and small game are relatively more productive resources, when measured as calories for human consumption per square mile per year, than are moose and beaver. These families, therefore, use the more

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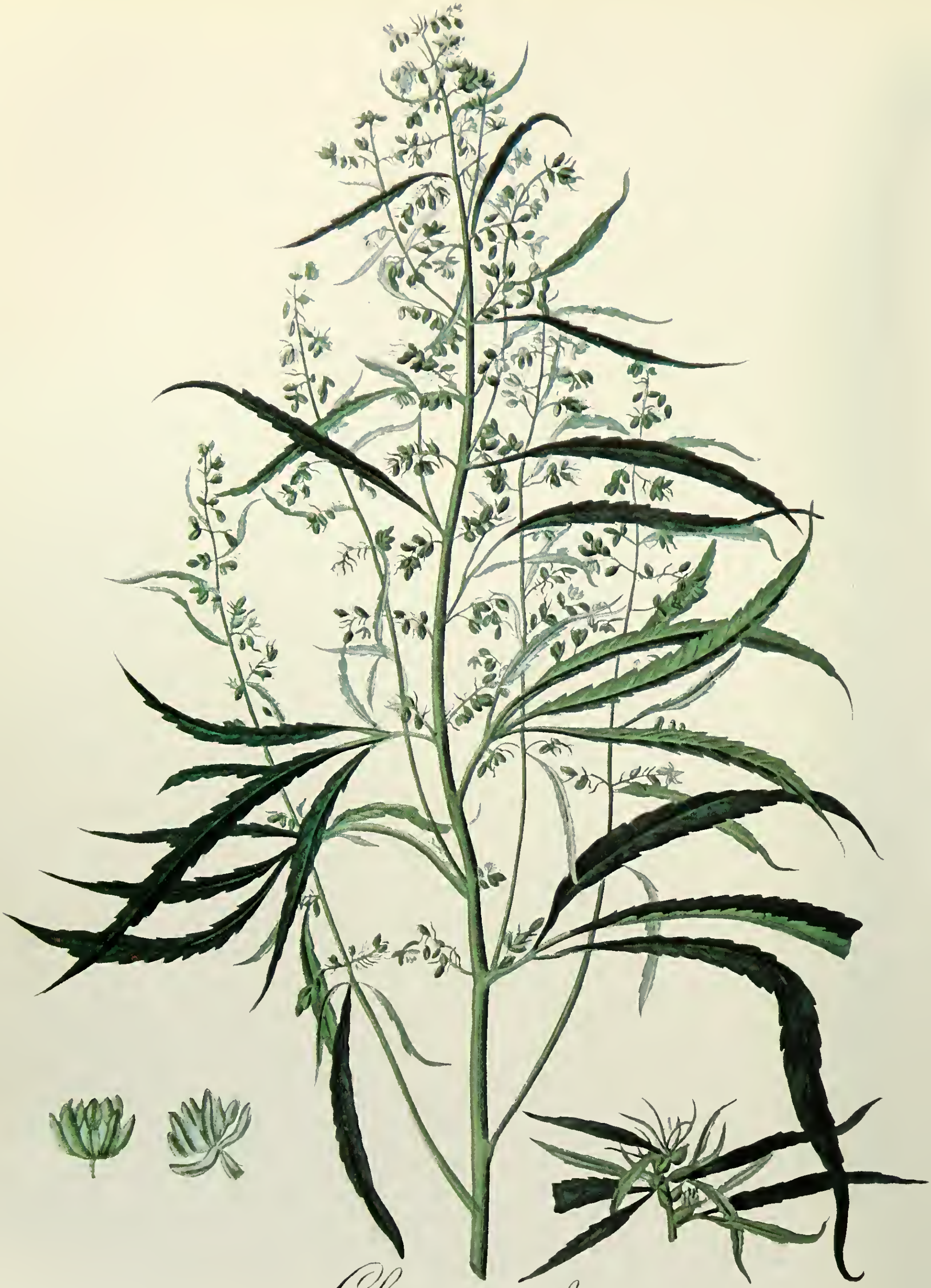


Chanvre cultivé

Hocquart del. et sculp

FROM "PHYTOGRAPHIE MÉDICALE,"
BY JOSEPH ROQUES, PARIS, 1821.

Man and Marijuana

Thousands of years before it became the superstar of the drug culture, Cannabis *was cultivated for fiber, food, and medicine*

by Richard E. Schultes

Strange things often happen to plants after a long and intimate association with man: they travel around the world; they grow in unusual and sometimes inhospitable soils and environments; and they often hybridize. They may escape cultivation and become weeds, or they may be altered by selection for characteristics associated with specific uses. These interacting forces frequently result in an organism greatly changed from its wild progenitor. To unravel and understand such changes, the biology and economic history of these plants must be considered together. Consequently, the investigation of the biological evolution of a cultivated plant and the evolution of its uses cannot be divorced from a study of the natural forces that may have shaped its new and perhaps unnatural role.

A prime example of this interplay between man and his useful plants is the relationship between man and *Cannabis*, known in the United States, according to its use, as hemp or marijuana. Marijuana has been around for thousands of years and has earned deep respect in many different societies. Botanists have usually considered *Cannabis* a single species, *C. sativa*, but recent research indicates that there may well be several species. The present biological variability of the genus may be traced in part to the complicated history of its various uses.

Cannabis has long been cultivated for five principal purposes: for hempen fibers; for its oil; for its achenes, or "seeds," which man has consumed as a food; for its narcotic properties; and as a therapeutic agent in folk medicine and modern pharmacopoeias.

Despite its long history as one of the major crop plants and its utilization by millions of people in many parts of the world, *Cannabis* is still characterized more by what is not known about its biology than by what is known. This lack of knowledge creates serious obstacles to an understanding of the moral, social, and legal aspects of its contemporary use or abuse and is the basis of many contradictions in the botanical, chemical, medical, and pharmaceutical literature.

There is no way of knowing which use of *Cannabis* represents the earliest. Plant uses normally proceed from the simpler to the more complex. Early man could hardly have missed seeing fibers exposed in naturally retted stems, and the production of hemp goes far back in the archeological record. *Cannabis* is probably man's oldest cultivated source of fiber and the first to have spread so widely. Remains of hempen fibers have been found in several of the earliest centers of civilization.

Curious stone beaters and crude tools for pounding hemp, as well as pottery in which impressions of cords were baked, have been discovered at an ancient riverside fishing site in Taiwan. There is evidence from several localities in China and Chinese Turkestan that nearly 5,000 years ago Neolithic man made thread and rope from hemp. In fact, the oldest known name of *Cannabis* is the Chinese *ta-ma*, which originally meant hemp. The character for the word represents plants growing near a house and would seem to indicate that the earliest and most important use of hemp in China was as a source of fiber. The Chinese believe that the legendary emperor Shen Nung, patron of medicine and inventor of agriculture, first taught cultivation of hemp in the twenty-eighth century B.C. Hempen fabrics have been excavated from sites in Turkey dated to the late eighth century B.C., older than the Taiwan finds, and an Egyptian tomb of between 3,000 and 4,000 years of age has yielded speciments of fabric thought to be hemp.

Ancient sites in the Altai Mountains of central Asia have provided remains of clothing made of hempen fibers. In 500 B.C. the Greek historian Herodotus stated that the Scythians, who originated in this mountainous area, grew hemp for its fiber and that the Thracians made garments of hemp that closely resembled linen.

Cannabis arrived as a fiber plant in Europe from the north, not from the south. The Greeks and Romans of classical times did not cultivate it, although it had arrived in Europe from Asiatic regions to the east before the Christian era. Fiber for ropes and sails was apparently imported into Sicily from Gaul as early as the third century B.C., and the Roman writer Lucilius mentioned the plant in 120 B.C. There is little evidence that *Cannabis* was

FENNO JACOBS—THREE LIONS

Once in worldwide demand, Manila hemp was sorted in Philippine warehouses before being made into rope. Today Russia and Poland are the main producers of hempen fiber.

cultivated as a major crop in western Europe before the Christian era. In the first century A.D., the Roman historian Pliny the Elder detailed the preparation and grades of hempen fibers, and hempen rope has been recovered in England from the site of a Roman fort dated A.D. 140–180, suggesting its introduction by the Romans from Gaul. Pollen studies have shown that there was a continuously increasing cultivation of hemp in England from the early Anglo-Saxon period into late Saxon and Norman times, from about 400 to 1100. Whether Viking sailors used hemp is not certain, but hempen fabrics and fishing lines have been retrieved from Viking graves in Norway, and the plant was grown in Iceland in the early Middle Ages.

In medieval England Henry VIII required English farmers to plant hemp, and in Elizabethan times England's maritime supremacy created such demand for the fiber that it was always in short supply, thus encouraging the cultivation of *Cannabis* in the New World. It was first introduced to North America apparently at Port Royal, Canada, in 1606. In Virginia the first crop of hemp was planted in 1611, and the Pilgrims brought it to Plymouth in 1632. Hemp was exported to England by the colonies, and in pre-Revolutionary America the fiber was used in making clothing.

There were undoubtedly a number of independent introductions of hemp into the Spanish and Portuguese colonies of the New World. *Cannabis* was known in Chile as early as 1545, and seeds were sent from Spain to Peru in 1554, but it never became a major crop.

The fiber became increasingly important in the United States. Extensive hemp plantations, centered around Kentucky, enjoyed prosperity until the middle of the last century, when disruption during the Civil War and rising labor costs killed the industry. By the 1870s, little hemp was being commercially produced in this country, but *Cannabis* seeds had spread from the abandoned plantations. The plant is now found as a weed mainly in the north-central area and the Middle Atlantic and New England states. Today hempen fiber is produced mainly in Russia and Poland, although the finest quality comes from Spain and Italy.

While the production of hemp represents one of the earliest uses of *Cannabis*, it is possible that consumption of the roasted achenes for food occurred even earlier. The ripened achenes are extremely nutritious and have undoubtedly been ingested as a fat-rich food by many peoples, especially in times of famine.

Archeologists have found hemp achenes in a receptacle excavated near Berlin, Germany, dated, with some reservation, at about 500 B.C. Since the mature achenes are devoid of the intoxicating principles, this find would seem to suggest their use as a food or their burial as a source of nourishment for the dead.

Sometimes eaten in eastern Europe, hemp is today cultivated for its seeds, especially in the Ukraine and Manchuria. In the United States hemp seeds are valued as a feed ingredient for birds and poultry.

It is as a substitute for linseed oil in the paint and varnish industry, in soap making, and as a lubricant that hemp seed oil has been chiefly used. The achenes contain from 19 to 35 percent of a drying oil, a greenish yellow fluid, which is also used for emulsions in pharmacy. In many areas of Russia peasants burn hemp oil in lamps to light their homes, but there is little evidence that oil production represents an early or widespread folk use of the plant.

Today it is seldom realized that, from the earliest periods of primitive cultures to modern times, hemp has been one of the world's major medicinal plants. Furthermore, many contemporary investigators believe that in the future wholly new therapeutic agents will come from *Cannabis* or from some of its chemical constituents.

The medicinal value of hemp—often, of course, closely related to its psychoactive properties—is perhaps its most significant, and was possibly even its earliest, role in cultural history. The oldest known record of *Cannabis* as a medicine goes back 5,000 years to Shen Nung, who prescribed hemp for malaria, beriberi, constipation, rheumatic pains, absentmindedness, and female disorders; an ancient Chinese physician, Hoa-Gho, recommended a mixture of hemp resin and wine to deaden pain during surgery.

In Indian mythology, hemp was a gift of the gods; its medicinal virtues lowered fevers, fostered sleep, relieved dysentery, and cured sundry other ills; it also stimulated the appetite, prolonged life, quickened the mind, and improved the judgment. In ancient India especially, the true medicinal use of *Cannabis* was closely associated with its magico-religious functions. As in many cultures, narcotics or hallucinogens represented the medicines par excellence, assuming, because of their psychoactive power, a far more important role than the merely physically active medicines. The several systems of Indian medicine valued hemp. The medical work *Sushruta*, for example, recommended hemp as an antiphlegmatic, as a treatment for catarrh accompanied by diarrhea, and even as a cure for leprosy. The *Bhavaprakasha*, written about A.D. 1600, termed the drug antiphlegmatic, digestive, bile affecting, pungent, and astringent and recommended it to arouse the appetite, improve the digestion, and heighten the power of the voice. At one time or other, Indian medicine ascribed curative properties for almost all ills to hemp; it was reputed to control dandruff and relieve headaches, mania, insomnia, gonorrhea, whooping cough, earaches, and consumption. *Cannabis* is still widely used in Indian medicine.

As hemp spread, its fame as a panacea spread with it. When it penetrated Africa, it became in some areas the preferred drug for treating malaria, dysentery, anthrax, and tropical fevers. Across Africa today, the most varied medicinal properties are ascribed to hemp. The Mfengu and Hottentots, for example, value the plant for snakebite; before childbirth Sotho women partially stupefy themselves by smoking the plant.

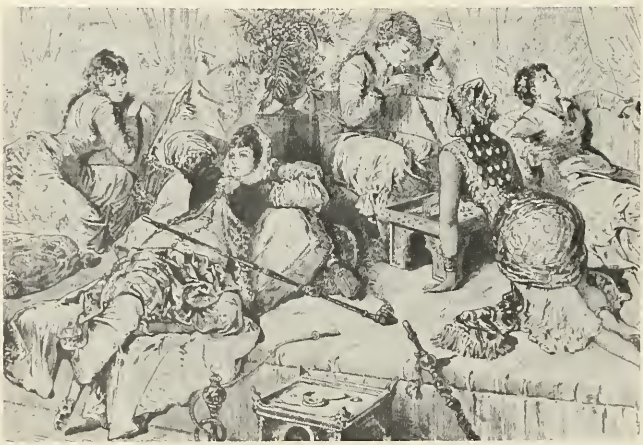
Even though *Cannabis* was used for a greater variety of medical purposes in India, it was in medieval Europe that it assumed most importance in both folk and "professional" medicine. Many of these European uses vary greatly from the Indian uses and can be traced directly to such early classical physician-writers as Dioscorides and Galen. Medieval herbals usually classified hemp as "hot and dry in the third degree." They distinguished the cultivated ("manured hempe") from the weedy ("bastard hempe") plant.

Little use was apparently made of bastard hempe, except as a remedy "against nodes and wennes and other hard tumours." Manured hempe, on the other hand, had a host of therapeutic applications. Boiled in milk, the achene was thought to alleviate a hot, dry cough. Crushed in white wine, it was held to relieve symptoms of jaundice. Fed to hens, the achenes were credited with increasing egg laying.

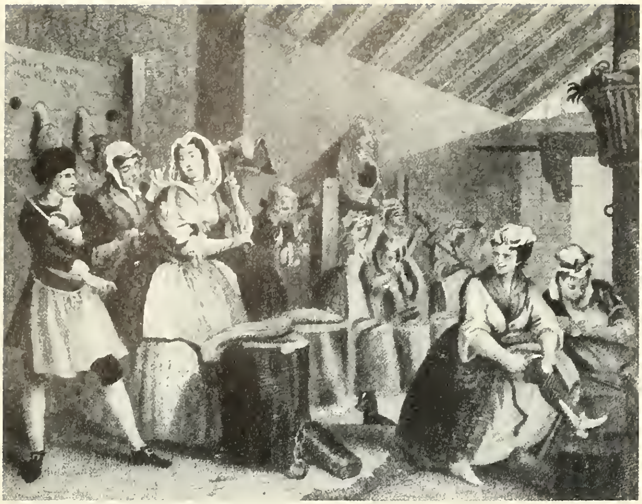
The medieval herbalists cautioned, however, that excessive use of hemp might bring on sterility. Parkinson, for example, stated in 1640 that "the seed . . . consumeth wind, and by much use thereof, doth disperse it so much that it dryeth up the naturall seed of procreation," while in 1619, Dodoens asserted that "it drieth up . . . the saede of generation" in men "and the milke of women's breasts."

Although not precisely a therapeutic use, it is worth noting the sixteenth-century report that a decoction of hemp "poured into the holes of earthwormes will draw them forth, and that fishermen and anglers have used this feate to get wormes to baite their hooks." This curious use acquires added interest in view of the suggestion that in some Asiatic localities early man may have valued hemp as a fish-stupefying plant, a use that may have led to its domestication.

In spite of the plant's long role in medieval medicine, modern European and American medicine did



"Secret Dissipation of New York Belles: Interior of a Hasheesh Hell on Fifth Avenue," depicted in the Illustrated Police News *of December 2, 1876.*



"THE HARLOT'S PROGRESS," BY WILLIAM HOGARTH — NEW YORK PUBLIC LIBRARY

Pounding the fibers with wooden mallets, women prisoners are shown breaking hemp in this seventeenth-century engraving.

not become seriously interested in the medicinal potentialities of *Cannabis* until the nineteenth century. During the last half of the century, more than a hundred articles on hemp appeared in medical journals. The principal effects of *Cannabis,* except for minor local irritant activity, concern the higher nerve centers. Consequently, in modern medicine the drug has been employed mainly as an analgesic, as a relief for insomnia, and to calm nervous restlessness. It usually takes the form of a tincture. It has also had limited use in inducing a euphoric condition helpful in reducing the pain of migraine headaches. Recently, hemp preparations have been shown to have antibacterial activity.

Cannabis is a difficult drug to use, since individual doses can be determined only by continued administration in increasing amounts until a desired effect is experienced. The most serious handicap in using hemp is difficulty in standardizing it, that is, the lack of certainty about the potency of the preparations.

At the present time, preparations of *Cannabis* are not available. It was included in the United States Pharmacopoeia and the National Formulary until 1937, but has been dropped from these American, as well as from most European, lists of official drugs.

Hemp's value in folk medicine was obviously associated closely with discovery of its euphoric and hallucinogenic properties, and knowledge of the narcotic effects of *Cannabis* may date almost as far back as its discovery as a fiber. Beset by hunger, early man experimented with all plant materials that he could chew. He could not have avoided discovering the intoxicating properties of *Cannabis,* for in his quest for the nutritious seeds and oil, he certainly ate the sticky tops of the plant, the most narcotic part. The euphoric, ecstatic, and hallucinatory aspects of the intoxication may have introduced him to an otherworldly plane from which emerged religious beliefs, perhaps even the concept of deity. The plant became accepted as a special gift of the gods, a sacred medium for communion with the spiritual world. And such it has remained in some cultures to the present.

While today *Cannabis* represents one of the most widely disseminated hallucinogens, its use as a narcotic, except in localized parts of Asia, seems to be relatively recent. As early as 5,000 years ago, Shen Nung, recommending hemp as a medicine, recognized its narcotic properties. One of its Chinese names meant "liberator of sin," indicating early condemnation of its use as an intoxicant. Eventually, however, its euphoric effects were accepted in China, as evidenced by a later name meaning "delight giver." A fourth-century report asserts that eating hemp causes the user to see spirits, and several hundred years later the Chinese were taking *Cannabis* for "the enjoyment of life."

The barbarian hordes of central Asia who lived west of China knew of the intoxicating properties of hemp. It was undoubtedly these nomadic tribes that spread the narcotic use of the plant. Among these people were the Scythians, who wandered widely in central Asia and southeast Europe, from the Altai Mountains to the Black Sea. There is evidence that they had a profound cultural influence on early Greece and eastern Europe.

Five hundred years before Christ, Herodotus described the Scythian use of *Cannabis:* "They make a booth by fixing in the ground three sticks inclined towards one another, and stretching around them woollen felts which they arrange so as to fit as close as possible: inside the booth a dish is placed upon the ground into which they put a number of red hot stones and then add some hemp seed . . .

immediately it smokes, and gives out such a vapour as no Grecian vapour-bath can exceed; the Scyths, delighted, shout for joy. . . ."

Recent archeological finds in the Altai Mountains have validated this curious report. Frozen Scythian tombs dated 500 to 300 B.C. have yielded a miniature, tripodlike tent over a copper censer—a contrivance for the inhalation of *Cannabis* vapors. Hempen clothing and the remains of *Cannabis* achenes were also found at the site.

All classes of Hindus now consume *Cannabis* in such preparations as bhang, a decoction made from powdered hemp fermented in milk or water, and ganja, the form in which it is usually smoked. But the plant may not have been widely used as a narcotic until a relatively late date in India. Indian society, as can be adduced from oral folklore, often condemned the secular use of hemp. There are references stating that one's learning is diminished with the use of *Cannabis* and that he who smokes ganja forgets even his own father's name.

Hemp was one of the most sacred plants in India. Knowledge of its psychoactive effects seem to go far back in history, as suggested by the deep mythological and spiritual beliefs about the plant. In ancient India, bhang was so sacred that it was reputed to deter evil, bring luck, and cleanse the user of sin. Harm and disaster visited those who trod upon the holy leaves of the hemp plant, and the most sacred oaths were taken on the hemp leaf.

The favorite drink of Indra, god of the firmament, was prepared from *Cannabis*. The Hindu god Siva taught that the word *bhangi* must be chanted prayerfully over and over at the time of sowing, weeding, watering, and harvesting the holy plant.

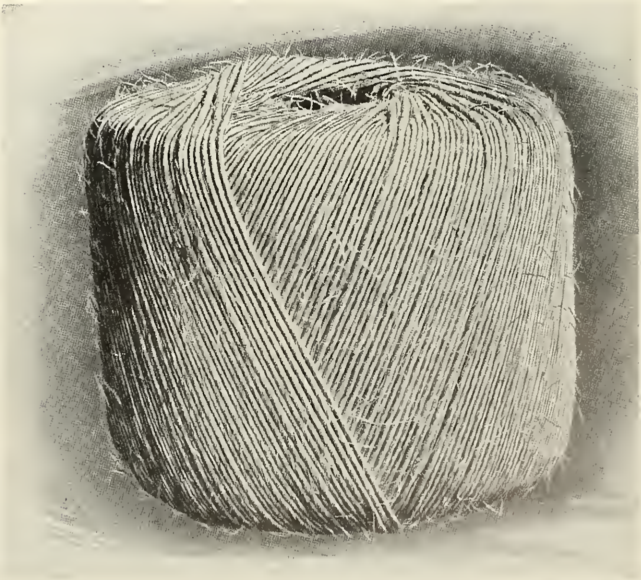
Thirty-five hundred years ago, the *Rig Veda* extolled the spiritual use of the narcotic god-plant soma, the identity of which has remained a deep mystery until recently. There was some suspicion that soma could be *Cannabis*, but recent studies by R. Gordon Wasson have identified it as the hallucinogenic mushroom *Amanita muscaria*.

Folklore holds that during the reign of Khusru (A.D. 531–79) the narcotic use of hemp was introduced to Persia by a pilgrim from India. The Assyrians, however, did employ hemp as an incense in the first millennium B.C., an indication that they may have used the drug for intoxication.

Knowledge and use of the inebriating properties eventually spread across Asia Minor. One of the enigmas of historical botany in this part of the world lies in the apparent absence of any direct mention of *Cannabis* or its products in the Bible. There are, however, several obscure passages in the Old Testament that have been interpreted as possible references to the intoxicating effects of hashish, the pressed, pure resin from the flowering tops of female plants.

Although at first prohibited among Islamic peoples, hashish spread widely. In 1378, the Emir Soudaun Sheikhouni tried to extirpate the plant from Arabian territory and imposed harsh punishments for the eating of hemp, but his efforts were in vain. As early as 1271, the use of hashish was so well known that Marco Polo described its consumption among the secret order of Hashashins, who used the narcotic to experience the rewards in store for them in the afterlife. Under the leadership of Hasan-Ibn-Sabbah, a Persian nobleman, this group of fanatics was dedicated—

Continued on page 80



Not all the products of Cannabis *are hallucinogenic: for thousands of years the plant has been grown to make into rope and twine.*

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The Adaptable Raccoon

At home in a farmyard or suburban woodlot, this ecological opportunist has met the challenges of man and climate

by Dean Schneider

At a time when animal extinction rates due to man's activities are steadily climbing, a few species are not only maintaining their population levels but, in some instances, even increasing their numbers and ranges. The Norway rat, German cockroach, house sparrow, European starling, and common pigeon are some familiar animals that have adapted to, and benefited from, man's presence.

One well-known, native North American animal that has successfully adjusted to man's alteration of its original habitats is the North American raccoon, *Procyon lotor.* It is as widespread and probably as numerous now as it was before European settlement of this continent. Raccoons can even adapt to environments highly populated by humans, and their presence near areas of cover is often noted by surprised suburbanites.

Because it is so adaptable in its choice of habitat, the North American raccoon occurs from Panama through Mexico and the United States and into southern Canada. Scarcity of water and long winters seem to be the only limits to major extensions of the raccoon's range, and highest densities are reached in habitats of wetlands mixed with mature forests.

An important limiting factor for any species is the availability of food, and here again, the raccoon is adaptable. A good example of an omnivore, a raccoon will consume virtually anything edible.

In spring, the raccoon's most common foods are crayfish, frogs, insects, birds' eggs, nestlings, and almost anything else it can catch. Even hornets have been found in raccoon stomachs. During late summer and autumn, plant foods such as acorns, berries, and corn are increasingly important in their diet. Raccoons sometimes develop humanlike food fads: one individual reportedly feasted for some time on watermelon pickles thrown out by a trapper, and another subsisted on grease.

Raccoons constantly probe with their long, soft-skinned "fingers," and on finding an object or piece of food, they turn it over and over before discarding or eating it. This habit of poking into holes and feeling things is useful in finding such important food as crayfish, which they locate by probing into mud and under submerged stones. Raccoons seem to be fascinated by water; this, combined with their habit of fondling things, makes it appear that they are washing food or other articles. However, "washing" is probably not their actual intent; most food is eaten without the benefit of a bath.

In keeping with their occupancy

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Raccoons have nonretractable claws and long front toes that can be widely spread, features useful in climbing trees and probing small spaces for prey. Raccoons are also good swimmers; this combination of arboreal and aquatic abilities enables them to secure a wide variety of foods. Favored items in their omnivorous diet are frogs, crayfish, small land animals such as mice, snakes (opposite page), nuts, seeds, and fruits.

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of a broad ecological niche, their requirements for shelter are also not highly specialized. Raccoons are basically nocturnal and during the course of a night, one will travel rapidly for a period, investigate a particular area for an hour or so, then wander on again. When the sky begins to lighten, a raccoon will usually find a resting spot for the day. This may be a hollow tree, a bed under the roots of a blown down tree, or merely a tree crotch; or the animal may dispossess a muskrat family and sleep in their house of rushes. Sometimes a raccoon will just curl up in a clump of cattails for the day.

Raccoons gain weight prodigiously throughout the summer and fall; some males reach thirty pounds. About half this weight is fat, providing the energy that will sustain the animal during its winter dormancy.

Although much has been written on the behavior of raccoons, most of the information has come from studies of captives and autopsies. Little detailed information is available on free-ranging animals, their reproduction, and the rearing of their young. Until the development of radio-tracking technology, study methods had not produced enough of the kinds of data necessary for evaluating short-duration movements over small distances. Such movements occur when cubs first leave the den to travel with their mother and also when they begin to travel, and then to sleep, alone. These critical first movements are particularly difficult to observe in a small, secretive, nocturnal mammal such as the raccoon.

To study the behavior of free-ranging raccoons and obtain the kinds of information not before available, I used the automatic radio-tracking system maintained by the University of Minnesota at the Cedar Creek Natural History Area. Located thirty miles north of Minneapolis, the system is capable of locating animals on a minute-to-minute basis over a radius of several miles. The area is good raccoon habitat, consisting of gently rolling country with marshes, bogs, swamps, and upland woodlots of mature oak.

Minnesota is close to the northern limit of the raccoon's range, which made Cedar Creek additionally interesting as a study area. Remembering Aristotle's dictum, "Carve Nature at her joints," I felt that the study of an animal at the extreme of its range might make discovery of its survival mechanisms easier.

This was illustrated during the first spring of my study. Snow cover was present a full month later than usual because of a series of heavy snows in late March and early April of 1965. As a result, more than 50 percent of the yearling raccoons died of starvation. Adult mortality was not as high, although all animals were emaciated. In this area, raccoons, like bears, become very fat in the fall, then are dormant through the winter. Young raccoons, which are born in May, attain adult dimensions by December, but they are not as fat as adults, probably because they require so much food for growing that there is little left for deposition as fat during Minnesota's short warm season. A late spring would be particularly hard on these young raccoons.

Copulation normally occurs during mild spells in mid-March when males leave their dens to look for mates. Since the gestation period averages sixty-three days, the females were pregnant during the severe starvation period that resulted from the late spring. They had to use precious fat reserves for nutrition of the growing embryos, then nurse the cubs while building themselves up from abnormally low weights. (Males do not bring food to the mother and play no role in raising the young.)

Despite their poor condition in the spring, all radio-tagged females of reproductive age produced litters, and all of their offspring grew well and denned successfully the following winter.

Because the reproductive phase is the most critical stage of an animal's life cycle, my research at Cedar Creek was specifically designed to provide data in this area. With the help of the staff at Cedar Creek, I spent March through December radio-tracking as many females and their young as we could tag and monitor, concentrating, initially, on five adult females that we assumed were pregnant.

In late March, the females occasionally moved out of their winter den trees at night and slept at other sites. By early April they increased their movements and stopped using their winter dens altogether. During the next two weeks they covered much of their home ranges of a mile or two in diameter. Some home ranges overlapped, but contacts between individuals were avoided. Although activity usually took place at night, the raccoons sometimes started several hours before sunset.

Most beds were on the ground in widely scattered locations and were seldom reused. As April progressed, snow cover disappeared and acorns became available for food. Also, as the wetlands thawed the raccoons were able to catch aquatic prey such as crayfish.

This movement pattern continued into May; then, within a five-day period in the middle of the month, each female began returning daily to a specific hollow tree. This was about sixty days after the study began in mid-March, and the birth of the young was imminent. Within the next few days, all of the females gave birth in the hollow trees they had selected as dens for their new families. Each of these trees had a hole about six inches in diameter, and at least eight feet off the ground, that opened into a cavity four or more feet deep, providing a comfortable chamber for the four to five offspring that constitute an average litter size for the species. In other areas of their range, raccoons also use rocky crevices or even the abandoned burrows of other animals, but hollow trees seem preferable.

Newborn raccoons are dark gray and lack the characteristic black

Fallen logs can serve as platforms from which to search for underwater prey, but if the log rolls, the raccoon may fall off.

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On a foray out of its den, this raccoon cub is beginning to develop its tree-climbing skill.

mask and ringed tail of the adults. These features develop within a few weeks. By the end of the fourth week, the cubs' eyes open, a few teeth begin to erupt, and the young start to crawl about in the nest. They can cry very loudly, emit twittery noises, and even growl.

The females foraged for food each night, leaving their young alone for eight to twelve hours, but they spent each day in the den tree nursing the hungry cubs. When the cubs were seven to nine weeks old, they moved with their mother to a permanent ground bed in an alder wetland or a white cedar swamp and remained there while the female continued her nightly travels. At this time we captured the young and put small radio collars on them.

At the age of nine to ten weeks, the cubs attempted to follow their mother, but she quickly left them behind and they would return to the nest together. It was interesting that the cubs, which were too small to fend for themselves, were left alone for many hours at a time, and that, on their own, they could get back to the nest, which was sometimes more than one hundred yards away. They may have used scent trails to navigate back to the nest. There was little danger from predators since most of the raccoon's natural predators in the area have been eliminated by man.

After several days of leaving the cubs behind, the mother suddenly began taking them along on short trips, but she returned them to the nest before leaving for the rest of her night's travels to hunt for food. These trips became longer each night and after a week the family was together continuously. At this time they began using ground beds scattered throughout the home range. By midsummer the cubs were ten to eleven weeks old; tadpoles were plentiful, grasshoppers were becoming abundant, and berries were ripening. The family movement period shifted back to the later, dusk-to-dawn schedule, and the cubs probably began to find some of their own food.

When the cubs were about sixteen weeks old, another dramatic change occurred: the radio signals showed that some of the cubs were running ahead or trailing behind the mother. Captive raccoons are weaned at this age, and so we assumed that the cubs were becoming more independent and were finding all of their own food. Before long, the cubs were traveling without their mother and occasionally sleeping alone. The family association had now become quite loose, cubs bedded and traveled alone, with a littermate, or with their mother.

It was then September, which is early autumn in Minnesota. The first yellow tints were appearing in the vegetation, sumac was reddening, corn was filling out well, acorns were again on the ground, and the first frosts had lain upon the grass. A splendid summer was ending softly. After an extremely late spring, endless balmy days had been seasoned with just the right amount of well-spaced rain. The raccoons had profited well from this bountiful season. I was pleased, for seasonable weather meant reliable data. An abnormal season might have made the raccoons behave atypically.

The loose family ties continued as oak leaves turned crimson, then started to fall. Since spring, home ranges of the adults had remained constant, and the cubs, too, had always stayed within their mother's home range.

Then in late October and early November each of the adults began sleeping a second or third time in specific hollow trees. On other days they chose new beds as they had done since the cubs became motile. This was a new pattern, and as I suspected, it anticipated the onset of winter dormancy.

During the last half of October, there was a sudden increase in the number of frosts and a concurrent increase in the number of times family members bedded together. By early November, with freezing temperatures every night, the family again moved and bedded as a group. The first snows fell during this period, but each time the flakes melted within hours.

The animals were also moving for shorter periods. They usually began their travels about sunset, but bedded earlier, sometimes after only a few hours, rather than after their usual twelve hours of foraging.

The trees were bare now, the winds were raw, and all the marshes were frozen. On November 26 a heavy snow fell all day, the temperature dipped to five above zero that night, and the wind gusted to thirty miles an hour. The next morning I trudged through the snow to the base of one of the den trees. The signals rang in the earphones of my portable receiver: the raccoons were all safe in their tree and there were no tracks in the snow. I clicked off the receiver, and as the wind stung my face, I suddenly felt alone—it would be a long time until March, and the raccoons had left me to spend my winter as I would. They were fast asleep.

But they had provided much new information. Perhaps most interesting was the discovery that the Minnesota raccoons did not disband the way families do farther south. It was obvious that the coming of winter had strengthened the group bond that had previously been weakening as the cubs matured.

It may be that cubs need adult guidance to survive their first winter under the severe conditions found this far north in the species' range. In the south raccoons do not den for the winter, and cubs become independent at different times within their southern range. This suggests that their family behavior is as flexible and adaptive to changing conditions as their diet and habitat requirements.

Species that specialize narrowly in food type, choice of nesting site, and reproductive behavior are most threatened by a changing environment. As the pattern of man's land use continues to shift on an ever broader scale, such species may face rapid extinction, but the omnivorous, adaptable raccoon seems adequately equipped for a long survival. ☐

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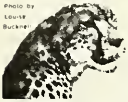

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Twilight of the Cree Hunting Nation

Continued from page 56

productive resources more intensively. Of the groups who must hunt their entire territories, about half show indications that a smaller proportion of their diet comes from moose and beaver than that of groups who hunt on rotated territories. The families who hunt less moose and beaver eat more fish and small game and also purchase more foods to take with them into the bush.

For those groups who used their hunting territories the year previous to the recorded year, the average harvests of both moose and beaver were just below the estimated productivities of each species. Furthermore the populations of moose and beaver have shown no abnormal declines in the last twenty years.

The extent to which the Waswanipi actually behave in accordance with their ecological knowledge is important. One major reason for the consistency of their behavior is the allocation of rewards to those who practice ecologically sound hunting practices. The Waswanipi say that *Chuetenshu* and the animals will be angry if a hunter kills for self-aggrandizement. A hunter's kills, especially those of moose and beaver, become public knowledge, since members of a group often receive portions of an animal killed by an individual, and meat is widely distributed in the settlements to families not hunting full time. When hunters return to the settlements, the hunting results are a major topic of conversation. A hunter's reputation rests on the public knowledge of his kills, and this reputation is an important component of his status in the community.

Cree who are considered outstanding hunters are those who do not experience ups and downs in hunting success. Numerically, they may not have the highest kills in any one year, but year in and year out, they consistently have the greatest success. A man's reputation as a hunter is therefore tied to his success in managing the game populations on which he depends, not his success in killing large numbers of animals. The result is that good ecological management is rewarded in the political arena.

The success of the Waswanipi Cree, and of the James Bay Cree as a whole, is a testament to the importance of giving priority to ecological principles. The James Bay Cree have been able to adapt to, and integrate their hunting life-style with, the changes brought by white men partially because of the ecological stability they help to maintain. The land and its resources are a touchstone of the Cree's security and vitality. Knowing the land will always be there, they have felt secure that there would be future generations of Cree. While they no longer depend solely on the land for their nutritional, material, or spiritual needs, the Cree believe that the land will remain a vital part of their way of life. Their vision and practice can be a model for other North Americans who are struggling to rebuild a balance with their environments. It should be a model for those whites who propose to develop the James Bay region, especially the planners of the recently begun James Bay hydroelectric project.

Confronted with the plans for this project, the James Bay Cree have had an almost uniform response—they ask what the project will do to the land and express concern for the fate of future generations of Cree. They have not opposed the project in principle, but if the proposed changes harm the land and the Indians' future, they do not want them. If, however, the changes are ecologically sound, the Cree want to give consideration to the project as they have to other changes in the past.

The authorities involved in the planning and development of the project have not satisfactorily answered the Cree's questions. The planners have had very few specific ecological answers, because getting the relevant information would require delaying the project and possibly reducing its economic and political benefits. But the Cree have implied that before the economic, political, and social implications of the project are discussed, they want to consider the ecological implications. So far, the James Bay Cree's reactions to the project have not been understood, much less dealt with, by the development planners. ☐

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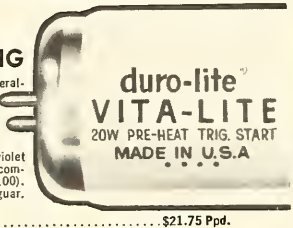

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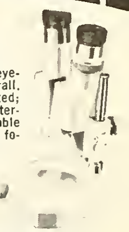

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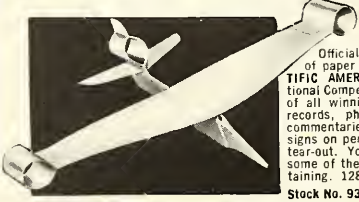

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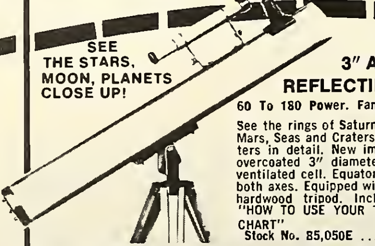

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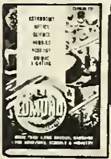

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To Kill a Honeycreeper

Continued from page 39

two white-eyes were transferred to a large mesh cage and exposed to the outdoor lowland conditions. After only five nights of lowland exposure two of the honeycreepers were obviously ill. After ten nights all honeycreepers were suffering from acute avian malaria; the packed cell volume of one individual had plummeted to 21 percent, and an estimated 97 percent of its red blood cells had been invaded by the malaria parasites. Significantly, of the eleven exposed white-eyes, only one had contracted avian malaria, and this a relatively light infection with only 1.5 percent of the red blood cells showing evidence of parasites. There was obviously a marked difference in the susceptibility of the two groups to the disease. Equally obvious, the lowland environment of Kauai was still exceedingly hostile to the high-forest honeycreepers.

An interesting sidelight of this experiment is worth mentioning. The test was terminated after three of the honeycreepers died. But swellings typical of the first stage of bird pox appeared on the feet and legs of the remaining honeycreepers. Judging from the accumulated observational evidence on the susceptibility of honeycreepers to this disease, bird pox, especially in concert with the weakening effects of avian malaria, would be fatal to the infected birds.

Another factor contributing to the incidence of avian malaria and bird pox was the phenomenon of periodic migrations of the native birds into lowland areas, usually during or after periods of heavy winter storms. These seasonal and/or weather-induced vertical movements, recorded by observers up to the 1920s, were relatively well fixed and may still exist today. They once were adaptive and probably helped the birds to avoid the excessive stresses of prolonged storms, but they became grossly maladaptive after the *Culex* mosquito arrived. Thereafter, movement into the pestilential lowland forests, even for short periods of time, exposed the honeycreepers to massive mosquito populations and the serious risk of infection.

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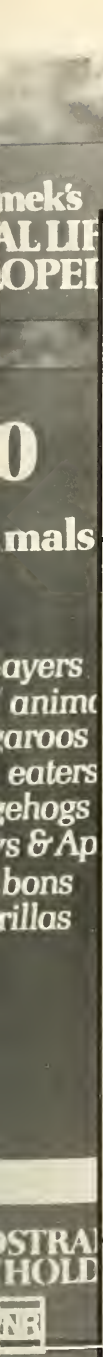

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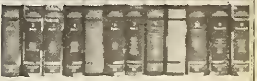

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When viewed in this context, the continuing inability to demonstrate avian malaria in the high-forest honeycreeper populations is not at all paradoxical. First, there are no mosquitoes to transmit diseases in the high forests; and second, should periodic vertical migration result in the honeycreepers contracting malaria in the lowlands, death is quite swift and the evidence quickly lost.

There is a ray of hope for the honeycreepers in some scanty evidence that the birds may be developing an immunogenetic resistance to malaria through natural selection. In a lowland exposure experiment on Maui in 1971, two honeycreepers did not contract malaria during the time span of the test. This may indicate an evolving genetic immunity against malaria, a development most likely to occur in the variable interphase zone between mosquito-infected and mosquito-free areas.

There is another intriguing and encouraging observation which was recorded in *Elepaio*, the journal of the Hawaii Audubon Society. Amateur ornithologist Blanche Pedley reported:

> About a month ago I began hearing bird calls which I had not heard in these parts before. In a few days I was able to catch fleeting glimpses of small, plump, greenish birds, some quite yellow. Although I was never able to see white eye-rings, I was sure I must be seeing mejiro [the white-eye]—the birds could not possibly be amakihi! A few days later I saw four or five feeding on the blossoms of thunbergia vines growing over guava trees

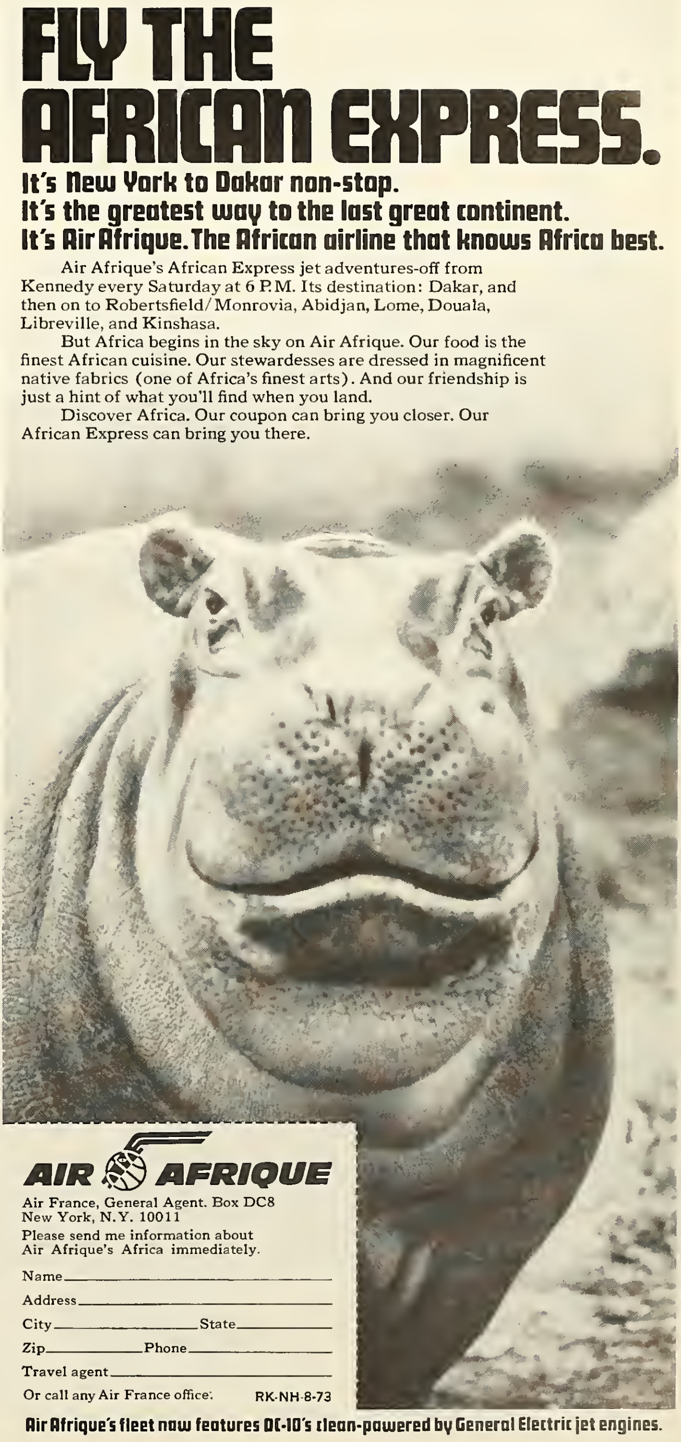
within a few feet of our house. Two were also searching for food around clusters of ironwood cones on the tree beside our garage. I was no longer in doubt. They were amakihi.

This account, written in 1961, indicates that the native amakihi had reinvaded a former habitat within the mosquito zone. Unfortunately, this account stands alone. No further observations of honeycreepers recolonizing former lowland habitats have come to my attention. Perhaps it is occurring elsewhere, but the paucity of such accounts suggests that honeycreepers are not bursting out of their mosquito-free high mountain sanctuaries, despite the availability of otherwise suitable habitats in the lowlands.

There is nothing we can do to retrieve those species that have been snuffed out. We are obliged to accept the tragic loss of many of Hawaii's endemics, the magnitude of which has been aptly summarized by biologist Winston Banko:

> At least 25 kinds of birds—40 percent of the endemic birds known to have inhabited the islands—have become extinct in the historic period. In fact, Hawaii's loss of 25 species comprises more than 15 percent of all kinds of birds which have become extinct in the world since 1600!

There are, however, significant things that can be done to halt the further decimation of Hawaii's remarkable avian heritage. First, we must learn to recognize and appreciate the values, both scientific and esthetic, of the native Hawaiian biota and to incorporate these values into the legislative and administrative processes. Second, an immediate halt to the present, willy-nilly destruction of the remaining native forests is necessary, whether that destruction is taking place in the name of economics, multiple use, or as simple resource management dilettantism. The beleaguered mamane forest has already experienced decades of abuse through maintenance of massive herds of feral livestock for sport hunting, and recently federal funds were used to finance bulldozing of sizable areas of the native forest in the name of "habitat improvement." The forest



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is so weakened now that it cannot withstand many more carcsses from the heavy hand of man.

To control disease and disease vectors constructive steps can be taken, although it is most unlikely that the night-flying mosquito and the reservoir of associated introduced disease can be removed. A near continuous stream of birds still flows into the islands: some are game birds for hunters, some are nongame species for the cage bird trade, and others have been imported for wild release to "augment" the island bird fauna. Since inspection and quarantine procedures are incomplete, the way is open for the introduction of still more exotic and virulent pathogens. A number of diseases have already been brought in by imported game birds, including a gapeworm and a coccidium. Serious avian maladies, such as avian encephalomyelitis, spirochetosis, Asiatic Newcastle disease, botulism, and visceral lymphomatosis are known to be harbored by a variety of game bird species; the first two have been found in game farm birds, the third in an imported shipment, and the last two in wild birds on the mainland. Thus, as long as exotic avian stock is brought into the islands, the threat of serious new diseases remains.

Lastly, one might well ask what would happen if the temperate form of the night-flying mosquito, *Culex pipiens pipiens*, were introduced and became established in the islands. Would the high-forest sanctuaries, now the last redoubt of the honeycreepers, be invaded by a disease-bearing form not limited, as is the tropical subspecies, to the warm and humid lowlands? I suspect the answer to this is not a happy one.

Every week hundreds of jets come thundering into Honolulu International Airport and to nearby military bases, obliterating the vestiges of Hawaii's age-old protective cloak of geographical isolation. Technological man has stripped the archipelago of its last and most potent line of defense. Whether we can now develop the sense of responsibility, the wisdom, and the fortitude necessary to protect that wild heritage, so gratuitously claimed and now so vulnerably exposed, will be determined over the next two decades. ☐

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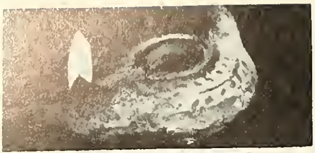

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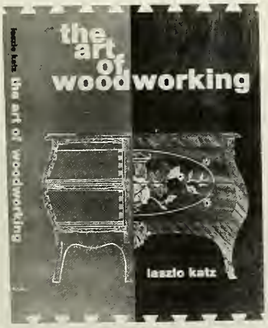

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Man and Marijuana

Continued from page 63

even to the point of committing murder—to the spread of an agnostic religious philosophy. Some philologists believe that the word *assassin* came into European languages from the Arabic *hashashin*, "eaters of hashish."

Although *Cannabis* was recommended as a medicine in classical Greece and Rome, its purposeful use as an intoxicant was apparently rare. By the first century A.D., however, the Romans customarily ate cakes containing hemp, which, according to Galen, were taken to promote hilarity but which, in excess, produced torpor.

Cannabis extended widely into Africa, partly under the pressures of Islamic influence. But the use of hemp far transcends Mohammedan areas and is found in primitive native cultures in such ingrained social and religious contexts that its arrival clearly predated that of Islam. In the Zambezi Valley, for example, there was an ancient tribal ceremony in which the participants inhaled the vapors from a pile of smoldering hemp; later, reed tubes and a variety of pipes were used, and the plant material was burned on an altar. The Kasai tribes of the Congo have revived the Riamba cult, a sect in which hemp, replacing ancient fetishes and symbols, became a god, a protector against physical and spiritual harm. Treaties and business transactions are sealed with puffs of smoke from a yard-long calabash pipe. In many parts of East Africa, especially near Lake Victoria, hemp-smoking and hashish-snuffing cults exist, and the plant is cultivated on a grand scale for its narcotic use. In southern Africa, the Hottentots, Bushmen, and Kaffirs customarily inhale the smoke of *Cannabis*, either burned free on the ground or in special pipes of horn and calabash.

Hemp has spread to many areas of the New World inhabited by large aboriginal groups, but the plant seems not to have penetrated significantly into native American religious life and beliefs. This may be because of the great number of native hallucinogens already firmly established in their magico-religious practices.

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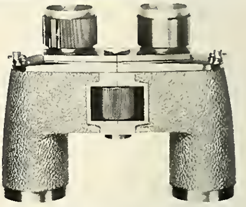

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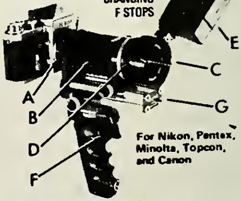

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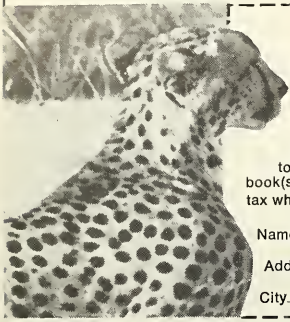

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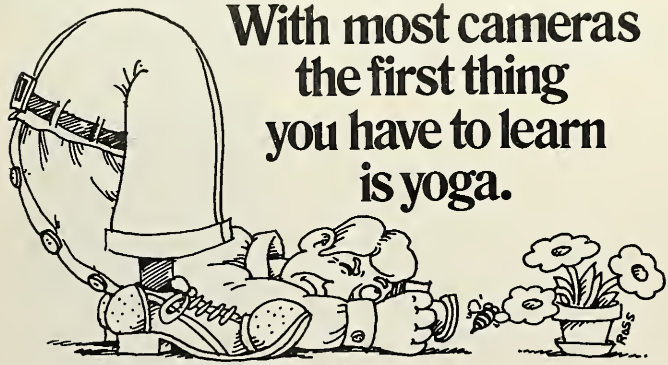

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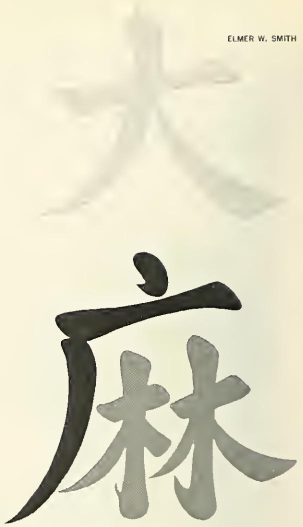

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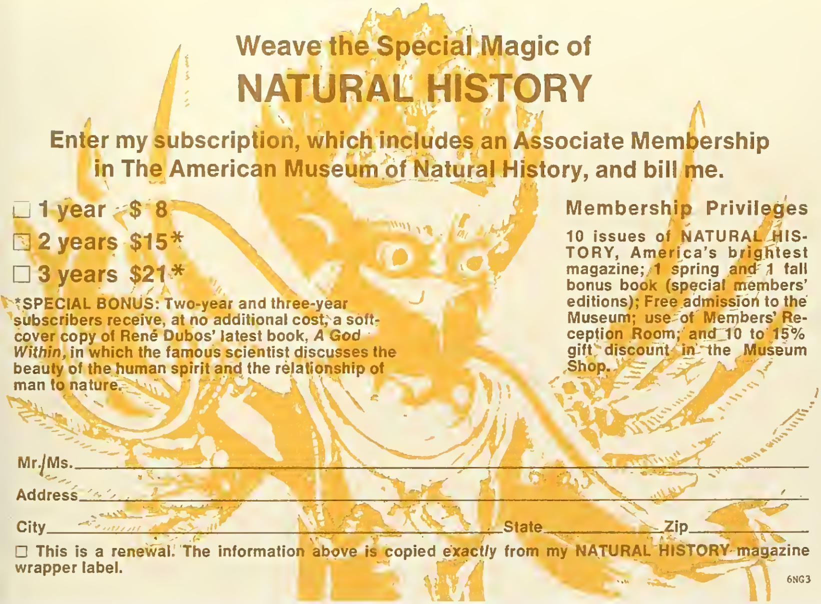

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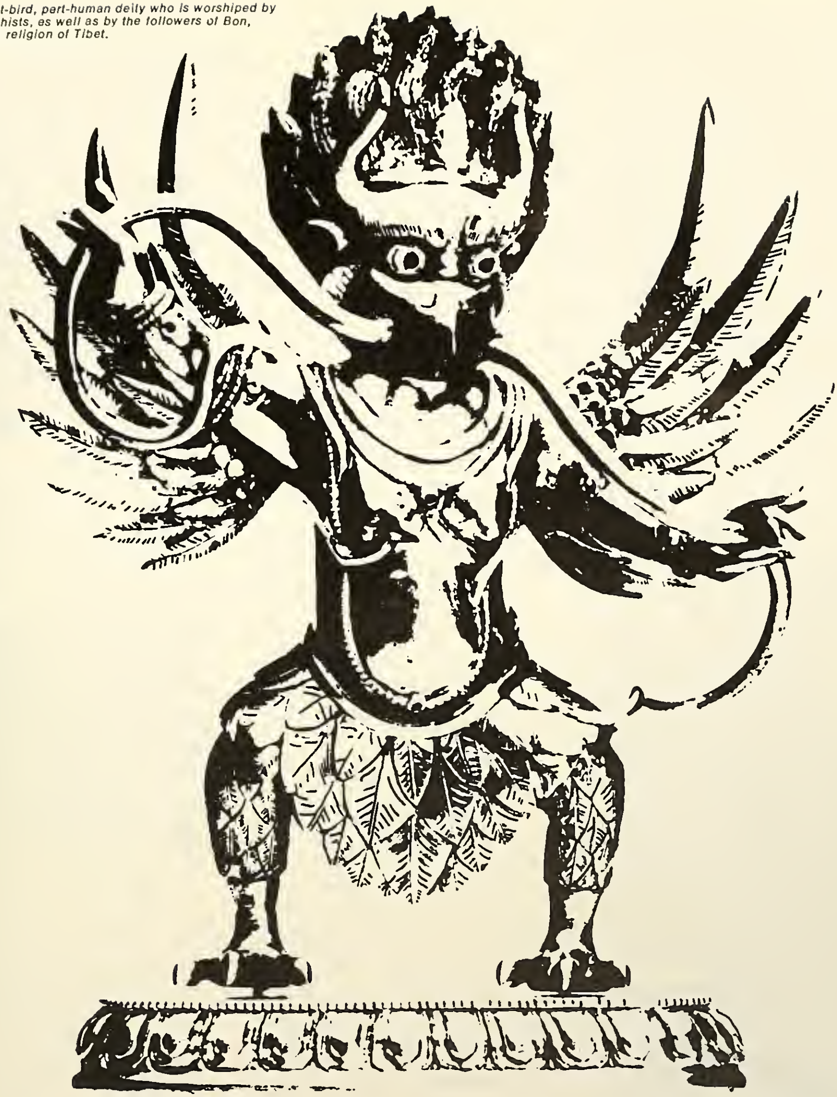

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A Dog's World View

Continued from page 18

comes marked and ball A is ignored. From this I gather that the odor markers Morris uses in identifying the ball he saw flying through the air remain effective for no more than five or ten minutes. The brief life of these odor markers is confirmed by the observation that Morris rarely seems to be confused by impact spots left on the flagstones from a previous retrieval.

Other variations of the ball game give additional glances into the world of Morris. Again they mostly happened by chance or were first suggested by Morris's behavior. I merely aided and abetted.

Morris has an excellent appreciation of the dynamics of ballistic flight. He probably learned to predict the flight of an object just as a child first learns to catch a thrown ball, and I have seen him grab the ball out of the air while he was running in any direction relative to its trajectory. He would make an excellent shortstop although getting the ball to a base could present a problem. This skill is not at all surprising or unusual in a predatory animal.

At the same time, Morris's appreciation of the effects of gravity seems oddly defective by human standards. On one occasion he began to gallop after the ball in anticipation of its usual course. But my aim was bad and the ball struck the wall on my right, shot off at an angle, hit the base of the maple tree, and flew off to the left. When the ball did not come bouncing across the lawn as usual, Morris returned to the flagstone walk and began casting about. He soon located the odor marker left at the base of the tree, the first ground contact made by the ball. He then spent time looking up into the tree, his forepaws resting on the trunk and his tail wagging wildly. Morris-type prediction probably suggested to him that the ball had ascended the straight and unbranched trunk of the big maple.

I have seen him behave similarly when the ball has bounded through high grass. While searching for markers, he may spend some time sniffing the tops of gently waving grass blades. This is all understandable: for Morris the ball is not an inanimate object governed only by Newton's laws.

The next situation, however, is more puzzling. It was March and I was spading over the vegetable garden when Morris felt that I should be throwing the ball. As I moved along each spade row, he stood beside me, yipping mildly with the ball in his mouth. Since this cut no ice, he began dropping his ball on the soil I had just turned over. As I moved along the row he picked up the ball and once more dropped it next to my spade. This time I turned a spadeful of soil onto the ball as he stood watching closely. A dachschund is a great digger and I expected him to immediately uncover his ball from the loose earth. But nothing happened; he just stood motionless in the same attitude of anticipation. Thinking that he was merely trying to bait me to pick up the ball and throw it, I continued along my row, glad that he was no longer underfoot. After a minute or so he began to cast around, wagging his tail—his usual behavior while hunting or searching for odor markers. While I finished the row and started another, he quartered the garden, returning several times to the general area where the ball was buried and urinating briefly. Although he sniffed about within a yard or so, he did not go to the exact spot. The ball was covered by only an inch or so of soil, which he saw fall into place. Why, with his exquisite sense of smell, did he not attempt to immediately locate the ball and dig it out?

This impasse continued as I spaded two more rows, thinking about dumb animals. Meanwhile the sun had set, and I did not wish to lose the ball. I was somewhat embarrassed when it took me several minutes of redigging to find the ball, something I am sure Morris could have done immediately. But he merely stood by and watched, pouncing as soon as the ball appeared. I repeated the burial a second time, this time taking care to mark the position of the ball with a small stick. There was the same result. But on repeated burials, if any part of the ball was visible, Morris immediately dug it out.

Here was another piece of behav-

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ior that seemed inexplicable. Perhaps, as my wife, Sonja, suggested, in Morris's world the ball became "my bone" through my act of burying it. A built-in sense of protocol inherited from his ancestors may have directed Morris that the ball became my property by this action. I noticed that he neither went directly to the spot nor did he "point" at it but merely circled it and marked nearby. My presence may have inhibited him from unearthing it, but perhaps he would have done so after I had left.

Simple experiences such as these fill us with wonder and promote our respect for skills and perceptions beyond our experience. Similar tests can be performed with almost any pet and may serve as an antidote for the depressing performances in which animals have been trained to act like humans.

It is tempting for us self-centered creatures to seek explanations for such behavior along the axis of intelligence and reason—the outstanding characteristics that have made our species so successful. But since this is only one among many axes that have measured animal survival, the polarization of our thinking along the clever—dumb axis tends to obscure understanding of animal behavior. It is more illuminating to regard perplexing behavior in animals as an opportunity to peer "through a glass darkly" into a different world, one where attributes like cleverness and dumbness are almost irrelevant, and the major axis that counts is species survival.

It is easy, for instance, to conclude that Morris would be much cleverer if he brought back the round object he had seen rolling across the lawn regardless of its odor, or that he would be much cleverer if he dug up his personally marked ball, which he had just watched being buried. A dog could be trained to do these things, but it is more interesting to try to find out why he chooses the ball with Morris-odor, why he must verify its outward course although he has already retrieved it, and why he will not touch the ball he saw buried under his nose. Actions that are bizarre by human standards could not have come about by chance or training. They must have had survival value at some time in the past. ☐

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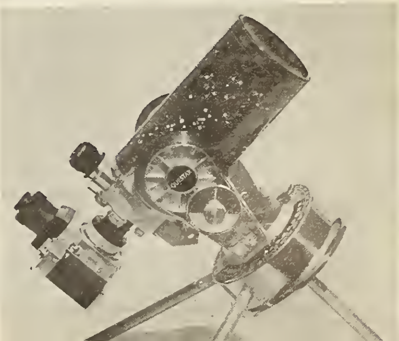

Food, Glorious Food!

COURTESY OF STEIN AND DAY

FOOD IN HISTORY, by Reay Tannahill. *Stein and Day, $15.00; 448 pp., illus.*

Like money, food did not interest early historians, and scant hard information has survived. We must look, for example, not to Thucydides but to Aristophanes for evidence of what the Greeks ate. But comic shopping lists are skimpy provender; they do not, that is, supply adequate documentation for the kinds of social analysis the modern scholar would like to perform on Hellenic and other previous cultures.

Archeological remains, too, can only take us so far in understanding how the world of antiquity grew its food and fed itself. And even for the modern period, the kitchen is the least honored part of the house. Cookbooks, rarely precise in our time, were hopelessly vague during the eighteenth and nineteenth centuries, the era when European culinary practices settled down into the cuisines we know today.

The rest of gastronomic literature is largely a playground for valetudinarians and pedants divided between besotted memories of edible opulence and fascistic strictures. Until very recently no one thought it important to record accurately what the people of the world were eating, how they cooked it, how they grew, marketed, and shared raw materials, or most important of all, what food contributed symbolically to their lives.

Curnonsky (in provincial France), Waverly Root (in Italy), and a handful of other, inadvertent anthropologists of this century have collected the fast-disappearing local recipes of some parts of the world. But recipes are inarticulate records. It remains highly ironic that Claude Lévi-Strauss has written more profoundly about the gustatory inner life of certain tribes of the Amazon than anyone ever has about the role of food in such more or less accessible cultures as those of France, the United States, and China.

Lévi-Strauss, of course, bypasses the diachronic, avoids history. This gives him a methodological leg up over Tannahill, who has had to make do with the

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available facts for *Food in History*.

She has, nevertheless, compiled a fascinating book for the general reader. If she rarely stays put for long enough to pin down a legitimate historical trend or give the full flavor, if you will, of a culinary point in time, she makes up for this almost inevitable superficiality with an unending stock of food anecdotes, exotic gobbets, and suggestive observations that will make you wish you knew more or that there was some way of knowing more about how food has evolved over the years.

Tannahill does not get mired in the standard "controversies" of gastronomic literature: whether Vatel was a chef or a maître d', who invented mayonnaise, where, and so forth.

Instead, she cheerfully transmits as much as she can of what is solidly known. Her first chapter is a series of speculations, since it deals with "food and cooking before 10,000 B.C." She hypothesizes that, before there was pottery, pots were made of mollusk or reptile shells or hollow bamboo trunks filled with food and stoppered at both ends. Some dishes must have been cooked inside animal stomachs, Tannahill says, in the manner of modern Eskimo and ancient Scythians. Actually, she need not have gone so far afield. One of the most honored French ways to prepare chicken, a specialty of the great Paul Bocuse, is *poularde en vessie*, done inside a pig's bladder. The result is sublime.

Indeed, one suspects that early men often ate well, not grossly. Tannahill cites the experiment of J.R. Harlan who sought to duplicate prehistorical conditions by harvesting wild grain with a flint-bladed sickle in a field in Turkey during the middle 1960s. He gathered enough grain in an hour to produce more than two pounds of usable, clean grain, twice as rich in protein as domestic strains and concluded that a three-week harvest in such a field would supply plentiful grain for a family throughout the year.

Early men liked shellfish as well as any modern gourmet, and shell remains indicate that millennia ago Indians on Santa Catalina Island decimated the local supply of abalone and then moved on to mussels. So much for the theory that Indians were better ecologists by nature than we.

Having surveyed the prehistorical diet and the origins of agriculture, Tannahill races efficiently through literate antiquity, stopping to note the invention of raised bread in Egypt (which required special strains of grain that did not need to be toasted before threshing), to quote Homer on one of those extramural barbecues known in bardic Greek as "equal feasts," and to devote space to an outline of the classical diet.

Unfortunately, the ancient authorities are unreliable in this area, a point Tannahill does not much stress. Petronius is only the leading example of many writers on food

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who exaggerated the excesses of upper-class Romans at table. This minor tradition of social criticism goes back at least to Cicero in Roman literature. He inveighed against the *piscinarii*, men who defiled the Republic's heritage of austerity by maintaining ponds of carnivorous fish.

There is a Roman cookbook (republished in English not so long ago) attributed to Apicius and disappointing to cook from. Tannahill understands this, but draws on Apicius for a clever comparison of the leading Roman condiment, a fermented fish sauce called *garum*, or *liquamen*, with its modern analogue in Southeast Asia. Hundreds of thousands of Americans probably tasted this sauce, called *nuoc mam*, in Vietnam. Unfortunately for them, the quality of *nuoc mam* deteriorated sharply during their presence. At the moment, the best modern *garum* comes from the Philippines and can be bought in Filipino markets in New York under the name patis. It is strong tasting, and difficult to get used to, but it is nutritious and the only conceivable spiritual link between ancient Rome and Saigon.

At any rate, Rome fell and people in Europe abandoned fermented fish sauce. They survived this loss and spent many centuries developing the diet we eat today. How they did it, nobody knows for sure. There are, however, landmarks in agriculture that did much to end the Middle Ages, for example, the horse collar and the three-field system. There is also a wealth of evidence about the spice trade.

Tannahill also spends some time describing dreary medieval dishes such as frumenty, a grain pudding, and mortrews, a sort of protoquenelle.

Meanwhile, the rest of the world went on eating in its own way. Tannahill hops continents with amazing speed, but tells us almost nothing about, say, China that puts modern Chinese food into a reasonable historical perspective. She is, however, enticing in her choice of non-European detail. We learn that the Aztecs ate newts and called them axolotls, that Arabs cooked with the fat from a sheep's tail, that the Mongols fermented mare's milk into kumiss, that fermented camel's

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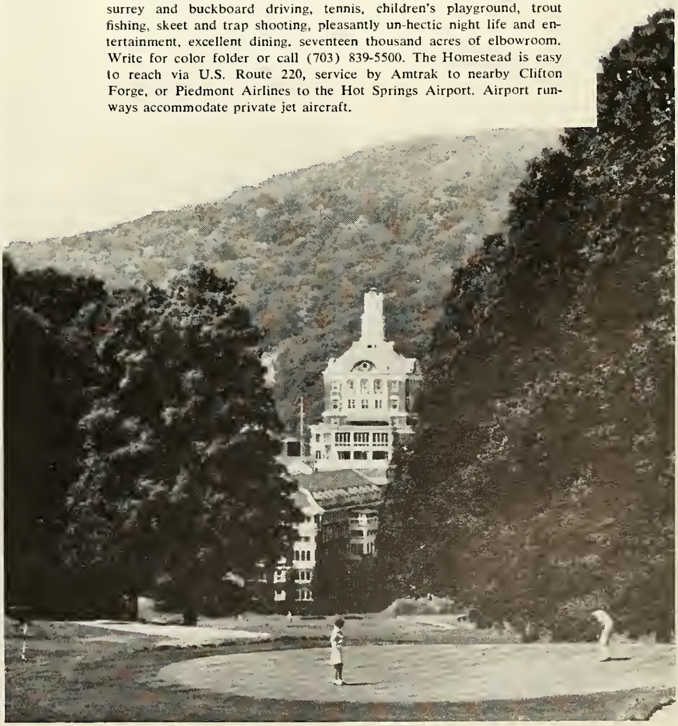

milk is called kephir, and that yak's milk similarly treated is known as airan.

This is a short book that tries to do too much. Luckily, Tannahill spends much of her time on Europe and devotes many pages to a history of the development of the modern menu. She quotes examples of medieval menus with their myriad courses arranged in an order that makes very little sense today—pigeons and veal and cabbage soup all mixed together. They were really smorgasbords linked by methods of preparation: cold dishes, roasts, boiled meats and stews, desserts. No one ate all of them.

From this disorderly profusion, the French carved out a highly ordered but equally confusing series of categories—relevés, entremets, entrées, rôts, pièces de résistance, assiettes volantes—which are defined clearly in this book, but still make no real sense to me.

Some of these terms survive in modern dining parlance but with other, very different meanings. An entrée, for instance, was originally a light concoction that prepared the way for something heavier. Entremets were served between other courses instead of coming at the end of the meal as they now do.

But the real difficulty is to think oneself back to a time when it seemed normal to alternate between meat and fish and fowl throughout the meal. Perhaps the modern hors d'oeuvre selection preserves some of the old, mixed-bag approach.

At any rate, the change to a menu built around individual dishes, instead of six at a throw, and meals that progress from fish to meat to sweet, instead of lurching back and forth among them like a bear in a garbage dump, did not evolve by esthetic plan. The contemporary meal is easier to serve, as Tannahill explains, and requires fewer flunkies per diner, as well as smaller brigades in the kitchen.

No one should regret this decline in outward grandeur at table. Few people ever were privileged to sit at those seventy-dish monstrosity banquets. And the modern meal permits leisure for savoring a few items, where formerly guests nibbled here and there, then hurried on to the next kickshaw.

The real problem with the modern meal is whether it will survive

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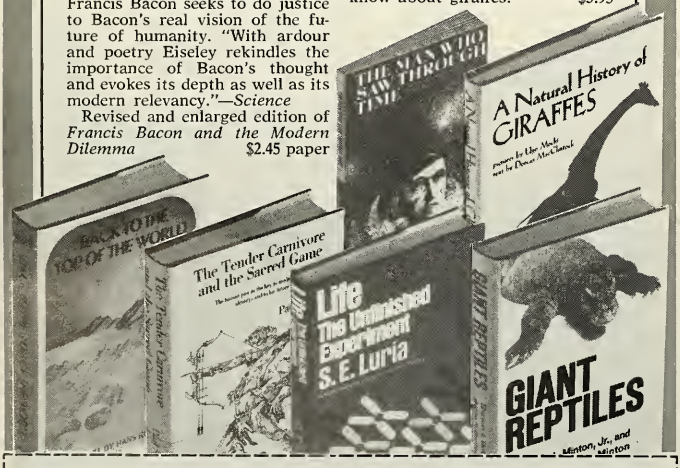
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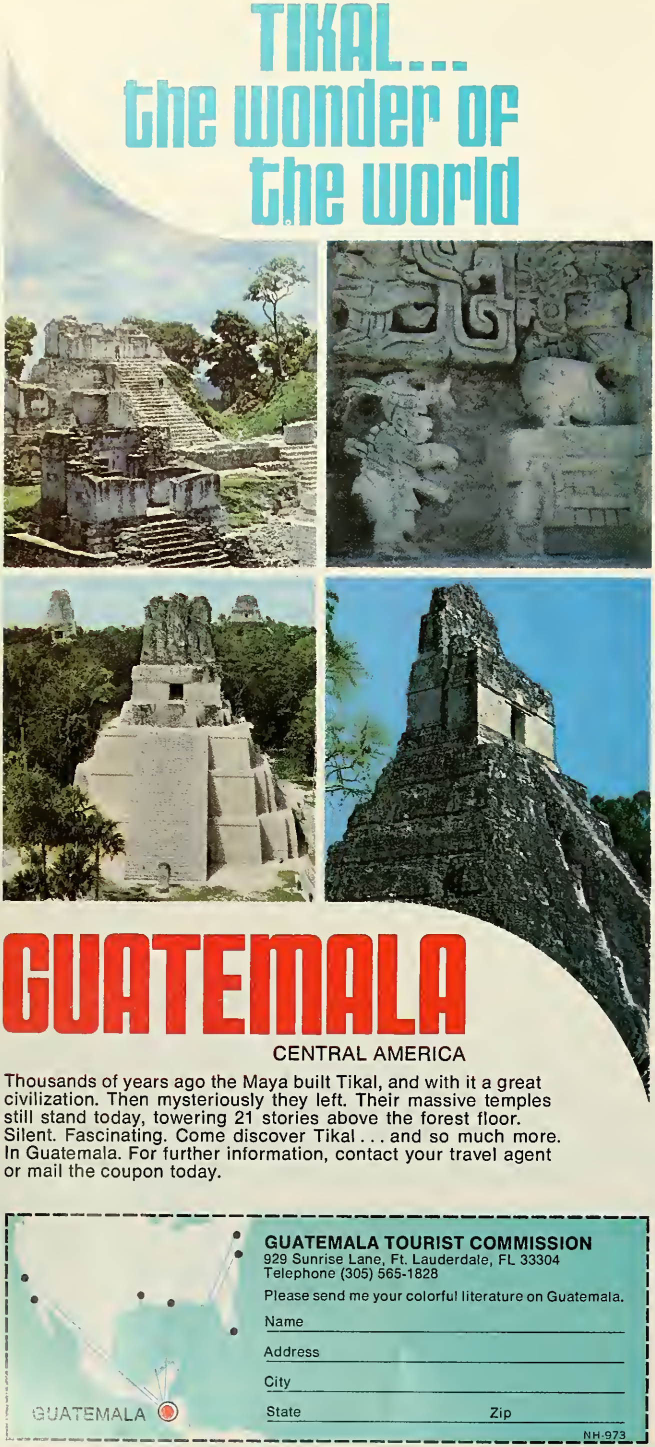

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at all, whether food as we know it will continue to play a role in human history without joining the buggy and other obsolete artifacts in the Smithsonian.

Tannahill confronts the future untrembling. "Complete dependence on 'natural' food will certainly be out of tune with the times by the end of the present century, and research cannot, in any case, stop short at merely discovering how to manufacture carbohydrates, protein, minerals, fats and vitamins, and how to weave them into eatable foods. It must go on to translate that knowledge into workable reality."

Eat, drink, and be merry, for tomorrow your local butcher will be selling pseudosteaks made from protein cultured out of petroleum.

Don't laugh. I was recently served a petroleum cookie by the French scientist who perfected the culturing process. It tasted quite like other cookies, but it didn't *feel* the same, if you know what I mean. I'll take a smelly glass of kephir any day.

Raymond Sokolov is former food editor of The New York Times *and author of* Great Recipes from The New York Times *to be published this fall by Quadrangle Books, Inc.*

NEW ZEALAND SPIDERS: AN INTRODUCTION, by R.R. Forster and L.M. Forster. *Collins Publishers, N. Z. $10.60; 254 pp., illus.*

Spiders are abundant, as many as two million per acre. All prey on insects, and the aerial webs of many species may catch more insects than their makers can consume. Despite their abundance and their importance as insect predators, spiders are not well studied. Entomologists and especially population biologists are often surprised that spiders cannot be as readily identified as butterflies, shells, and vertebrates, and that even common species found preying on agricultural insects in South or Central America have no names and are undescribed. Best known are the spiders of northern and western Europe and North America (especially New England), and also those of New Zealand, which has had a long tradition of specialists in spider taxonomy. R.R. Forster, director of the Otago Museum, is one of the foremost specialists on spiders. He and his wife, authors of this volume, estimate that the 500 known New Zealand species are only about one-fifth of the total araneid fauna of the island.

Unlike books on birds and insects, popular books on spiders are few, and this sumptuously illustrated book is comparable to the most elegant butterfly and bird volumes. The abundant illustrations alone make the book a worthy addition to any naturalist's library. The black-and-white illustrations are the unmatched art work of Barry Weston, and the outstanding photographs were taken by the authors.

The text is easy reading and a good introduction to the study of spiders in any part of the world, although not quite up to the standard of the illustrations. One has the feeling that the Forsters are better acquainted with the classical literature and other popularizations than with the current researches on ecology, behavior, and sensory physiology. The statement that sense organs have not been well studied, for instance, is certainly not altogether correct. Inclusion of some recent researches would have made a more exciting book. The absence of references to recent active researches in a popular summary must be quite discouraging to the biologists doing the work.

After chapters on structure and behavior, life histories, and spider relatives found in New Zealand, the book is divided into chapters by habits: the ground-hunting spiders, jumping spiders, web builders, and so on, with the last chapters on venoms, collecting, and photographing. Here and there are such interesting bits of information as that few New Zealand spiders balloon. Ballooning is the common dispersal mechanism of spiders: climbing up high the spider lets out strands of silk. When these are caught by the wind, the spider is lifted and becomes airborne. Not ballooning may be an adaptation for spiders living in dense forests and insular habitats; balloonist spiders might be blown out to sea. Actually we know very little about the ballooning habit of spiders, a lack of knowledge that results from the difficulty of identifying spiderlings.

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Celaenia is one of the group of mainly Southern Hemisphere orb weavers that do not construct webs but dangle a viscid globule and silk thread. That the globule attracts mainly male moths indicates that it is, not the "fascination" of the shiny globule that attracts insects as stated in old books, but probably pheromones. There are numerous spiders, not only in New Zealand but also in other parts of the world, that construct a snare of only a single line; it is difficult to imagine success in catching insects with such a snare. There are no observations as yet, but it is known that in several families male spiders find receptive females by following threads coated with pheromones, thus one might expect that the single-line snare is coated with chemical insect attractants. We just do not know.

To the knowledgeable specialist there are some peculiar, distracting errors in the volume, such as the statement that Toxopidae of New Zealand and Australia are related to Telemidae; presumably the authors meant Selenopidae. *Araneus,* the largest spider genus of worldwide distribution, is called *Aranea* throughout. Two photographs labeled "*Synotaxus,* Linyphiidae." show a linyphiid spider. But *Synotaxus* is a tropical American theridiid, a very different animal, a small elongated spider. I recently observed that *Synotaxus* sits under leaves in a position that makes it difficult to distinguish from leaf veins. The picture of *Tekella* is not the theridiosomatid to which the name is attached. I fear the Forsters have continued traditional New Zealand usage of names without consulting the type specimens of these names. But there are few such errors and these criticisms of a specialist should not detract from the enjoyment by the casual reader.

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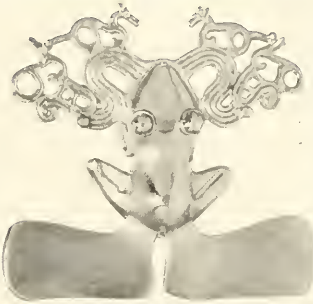

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Celestial Events

by Thomas D. Nicholson

Sun and Moon Although summer warmth continues into September, by August the days are clearly getting shorter and the sun lower in our sky. The sun's height, and the hours during which it shines, make August and September comparable to April and March. The difference, of course, is that in the Northern Hemisphere, the sun's warmth during the longer days since March has built up the heat energy stored in the earth and its air north of the Equator. So, although the sun is low and darkness comes earlier, winter is still far off.

In August, September, and October, we can expect bright, moonlit nights generally for about a week before and after midmonth. And we can expect to see the evening crescent moon during the first few days of each month, the morning crescent for a few days after the 20th, and no moon for the last week of the month. Dates of the phases are: August, full on the 13th, last-quarter on the 21st, new on the 27th; in September, first-quarter on the 4th, full on the 12th, last-quarter on the 19th, and new on the 26th; and in October, first-quarter on the 4th, full on the 11th.

The Harvest Moon The full moon on September 12 is the Harvest Moon, the designation given to the full moon that falls nearest to the autumnal equinox (September 22). At this time of year, the orbit of the moon at sunset lies nearly flat against the eastern horizon, where the rising full moon is coming up. Each day, the moon shifts to the east (left) in its orbit by about 13 degrees; this is why moonrise occurs later each day. But the effect on the rising time is diminished by the orientation of the moon's orbit to the horizon. Thus it appears that the full or nearly full moon rises at, or very close to, the time of sunset for three nights in a row—a real advantage to harvesters, who can work in the early night to finish the fall harvest.

Planets Venus is low and bright in the west, Jupiter well up in the southeast among the stars of Capricornus, after sundown. A few hours later, Venus has set, Jupiter is high and bright in the south, and Mars is coming up in the east, brightening rapidly as it moves from Pisces into Aries.

In the dawn sky, Jupiter will still be visible in the southwest in August, but it will have set before dawn in September. Mars, however, will be very bright and reddish in color high in the south. And Saturn, in Gemini, will be well up in the east.

August 18-19: Mars is near the crescent moon in the morning sky.

August 31: The crescent moon and Venus will be close tonight.

September 2: Mercury, at superior conjunction, enters the evening sky.

September 7: The bright star near Venus tonight is Spica, in Virgo.

September 8: Look for Jupiter near the moon tonight.

September 19: Mars has been moving to the east (left) through the stars of Aries. It now becomes stationary and begins moving to the west (right) as it approaches opposition in late October.

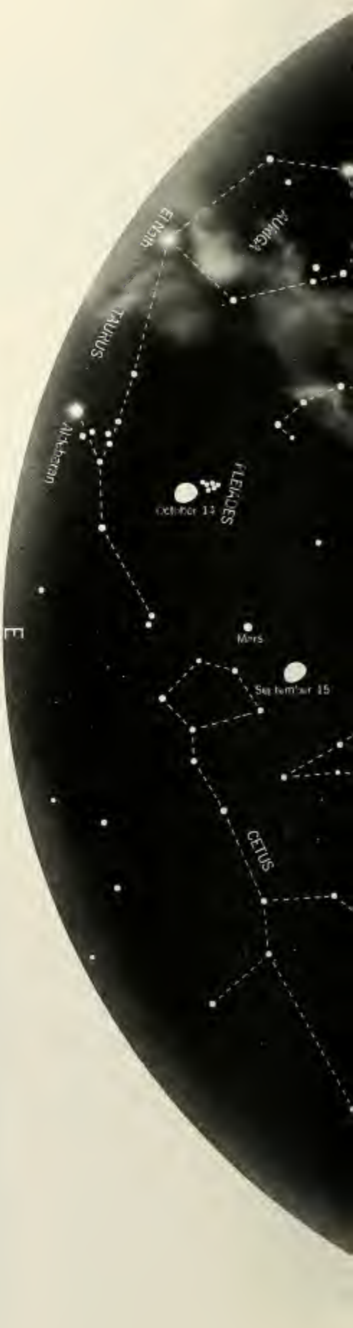
September 22: The sun arrives at the autumnal equinox at 11:21 P.M., EST, and autumn begins in the Northern Hemisphere.

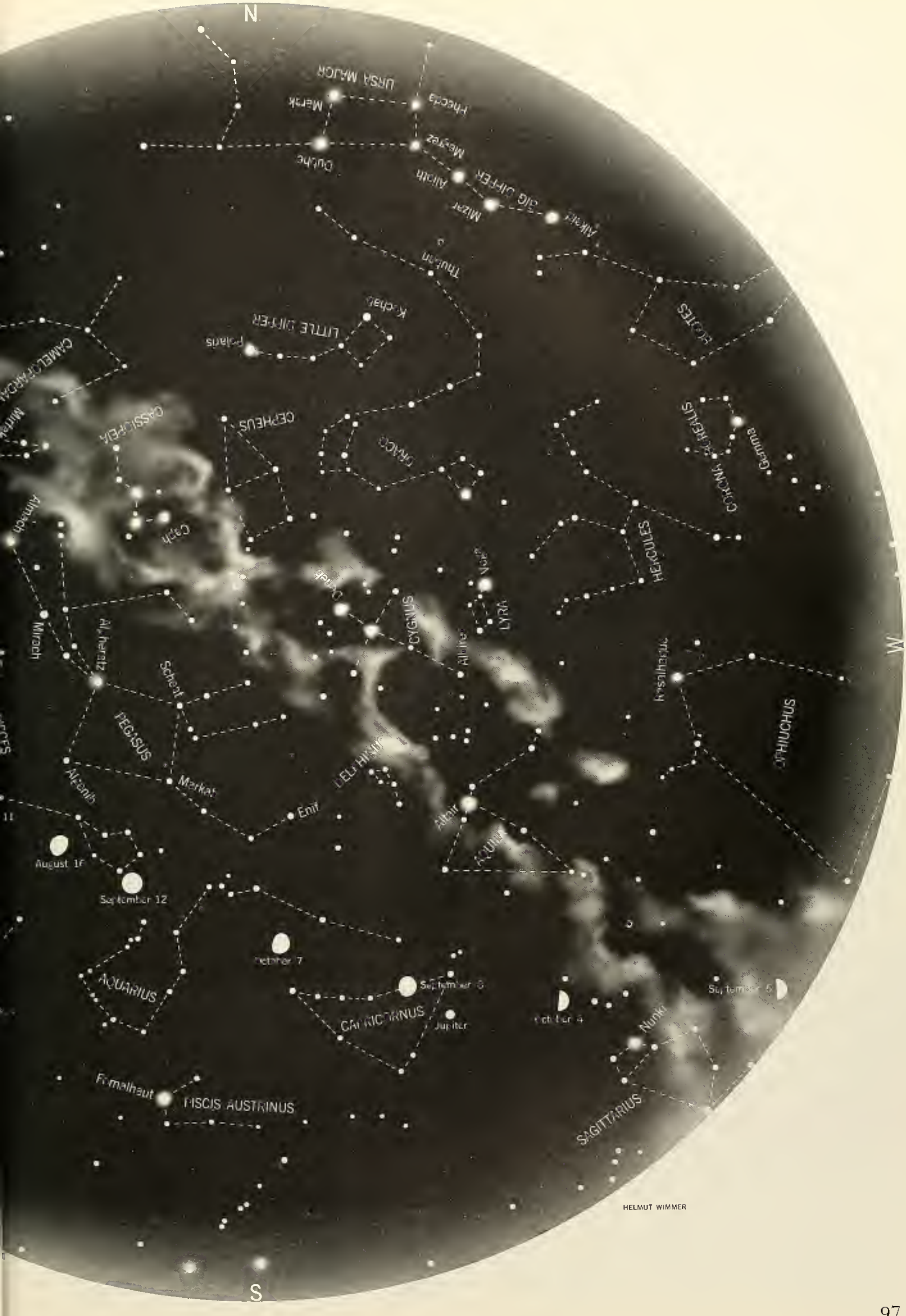
September 28: Jupiter, well past opposition, resumes direct (eastward) motion.

October 5: Jupiter is near the moon until it sets before midnight.

October 12: Mars is near the gibbous moon, just one day past full.

★ Hold the Star Map so the compass direction you face is at the bottom, then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 12:20 A.M. on August 15; 11:20 P.M. on August 31; 10:20 P.M. on September 15; 9:25 P.M. on September 30; and 8:20 P.M. on October 15; but it can be used for about an hour before and after these times.

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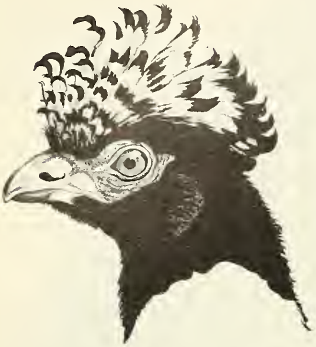
Curassows, guans and chachalacas



The American Museum of Natural History is pleased to announce the publication of **Curassows and Related Birds**, by Jean Delacour and Dean Amadon.

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Curassows and Related Birds is also a very beautiful book. Its 268 pages contain thirty color plates of the birds in their habitats, painted by Albert Earl Gilbert, George Miksch Sutton, and David Reid-Henry. There are also seventy drawings, maps, and photographs.

Curassows and Related Birds has been produced in a limited edition and is available through the Museum for the special price of $20.00, plus $1.00 for postage and handling. To order, please send check or money order to:

The American Museum of Natural History, Curassow Book, 77 West 77th Street, New York, New York 10024

Suggested Additional Reading

TO KILL A HONEYCREEPER

Birds of Hawaii. G.C. Munro. Charles E. Tuttle Company, Inc., Rutland, 1960.

Introduction to Parasitology. A.C. Chandler. John Wiley and Sons, Inc., New York, 1961.

The Hawaiian Honeycreepers. D. Amadon. *Bulletin of the American Museum of Natural History*, Volume 95:Article 4, New York, 1950.

Nine Doctors and God. F. J. Halford. The University of Hawaii Press, Honolulu, 1954.

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Marvels of a Coral Realm. W.A. Starck II. *National Geographic*, November, 1966.

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The Ice Age and the Caldron

On our tiny planet, spinning in an almost circular orbit at a nearly constant distance from our star, the climate varies greatly from place to place. The Sahara is different from the Antarctic. The sun's rays fall directly on the Sahara, obliquely on the Antarctic, producing a sizable temperature difference. Hot air rises near the Equator and cold air sinks near the poles, producing atmospheric circulation. The motion of the resulting air currents is deflected by the earth's rotation.

There is water in the atmosphere; when it condenses, rain or snow forms, releasing heat that, in turn, changes the motion of the air. Wind currents flowing over mountains or down into valleys also change the circulation.

Ground covered by freshly fallen snow reflects more sunlight back to space than when it is snow-free. The snow-covered ground becomes still colder. When more water vapor or carbon dioxide is released into the atmosphere, infrared emission from the surface of the earth is increasingly blocked. Heat radiation cannot escape from this atmospheric greenhouse, and the earth's temperature rises.

At one point in time on one tiny planet, the weather is complex. The climate, at least to some degree, is unpredictable. In the past there were more violent climatic fluctuations. Whole species, genera, classes, and families of plants and animals were extinguished, probably because of climatic fluctuations. One likely explanation for the extinction of the dinosaurs is that they were large animals with poor thermoregulatory systems. Unable to burrow, they were unable to accommodate to a global decline in temperature.

There is an as yet unexplained connection between the extinction of large numbers of small aquatic animals and reversals of the earth's magnetic field. The early evolution of man is closely connected with the emergence of the earth from the vast Pleistocene glaciation.

The reason for these climatic changes is still under heated debate. It may be that the amount of light and heat put out by the sun is variable on time scales of tens of thousands or more years. It may be that climatic change is caused by the slowly changing tilt of the earth's rotational axis relative to its orbit. There may be instabilities connected with the amount of pack ice in the Arctic and Antarctic. It may be that volcanoes, emitting large amounts of dust into the atmosphere, darken the sky and cool the earth. It may be that chemical reactions reduce the amount of carbon dioxide and other greenhouse molecules in the atmosphere, cooling the earth.

There are, in fact, some fifty or sixty different and, for the most part, mutually exclusive theories of the ice ages and other major climatic changes on earth. In addition to its considerable intellectual interest, an understanding of climatic change may have profound practical consequences. Man is influencing the environment of the earth, often in ways poorly thought-out, ill-understood, and for short-term economic profit and individual convenience, rather than for the long-term benefit of the inhabitants of the planet.

Industrial pollution is churning enormous quantities of particulate matter into the atmosphere, where it is carried around the globe. The smallest particles injected into the stratosphere take years to fall out. These particles increase the albedo, or reflectivity, of the earth and diminish the amount of sunlight that falls on its surface. On the other hand, the burning of fossil fuels, such as coal and oil and gasoline, increases the amount of carbon dioxide in the atmosphere, which, because of its significant infrared absorption, can increase the temperature of the earth.

There is a range of effects pushing and pulling the climate in opposite directions. No one fully understands these interactions. While it seems unlikely that the present amount of pollution can produce a major climatic change on earth, we cannot be absolutely sure. It is a topic worth serious and concerted international investigation.

Space exploration plays a role in testing theories of climatic change. On Mars there are periodic massive injections of fine dust particles into the atmosphere; they take weeks and sometimes months to fall out. We know from the Mariner 9 exploration that the temperature and climate of Mars change severely during such dust storms. By studying Mars, we may better understand the effects of industrial pollution on earth.

Venus is a planet that appears to have undergone a runaway greenhouse effect. A massive quantity of carbon dioxide and water vapor has been released into its atmosphere, sufficiently cloaking the surface to permit little infrared thermal emission to escape into space. The greenhouse effect has heated the surface to 900°F. or more. How did this greenhouse overkill happen on Venus? How do we avoid its happening here?

Study of our neighboring planets not only helps us to generalize the study of our own, but it has the most practical hints and cautionary tales for us to read—if only we are wise enough to understand them.

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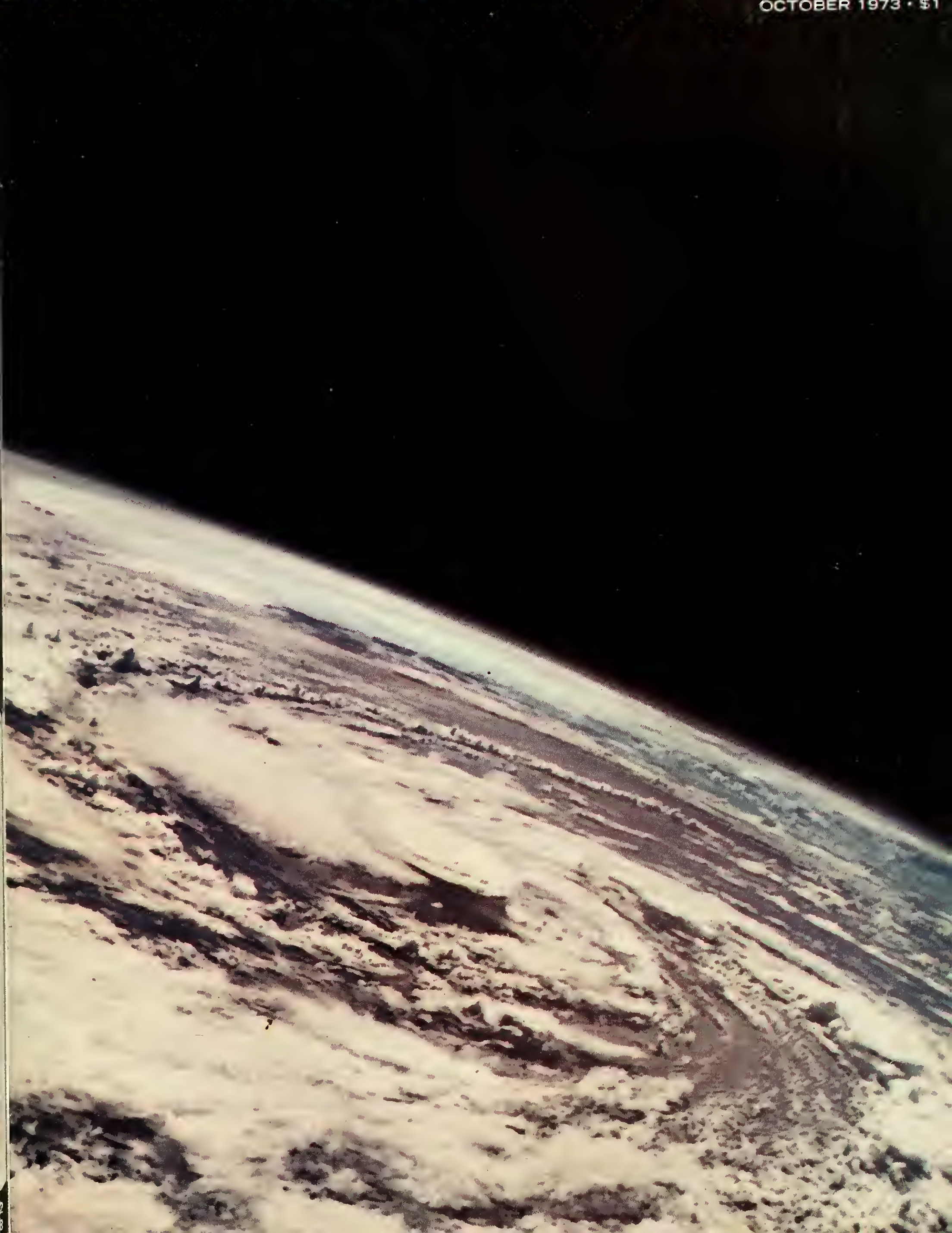

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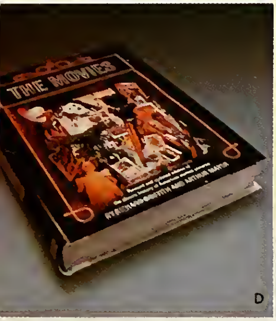

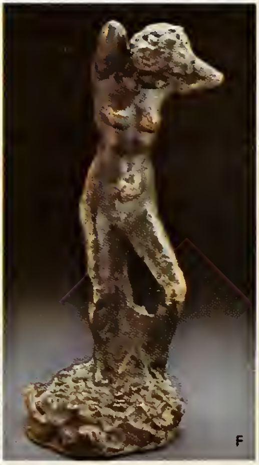

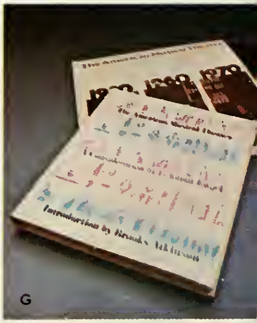

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Yet you need only read a single issue of the magazine to know it's not so.

Of course we're concerned about the environment. You don't publish a magazine like ours for 73 years without getting that way. And with a name like Natural History, it's hard not to become identified with the environmental cause.

We do try to inform a reader. And we entertain him, too. But we never lecture him, because we know that's the surest way to lose him.

Last issue, we had an article on the life and death of Florida's coral reefs. If we'd been so inclined, it would have been the perfect place to draw a few pointed conclusions. But the answer was no.

The reason? Editor Alan Ternes tells it better than I do:

> "There's a real temptation to jump on this bandwagon and try to preach to people about environmental issues. The coral reefs in Florida...it's a very complex picture. It's also fascinating. Why are a number of reefs dying? Is this a trend?
>
> "We showed the beauty of the coral reefs, we showed some of the dead ones so you can see what happens. But we didn't say at the end, now you should get out and pound the pavement. That's for the people to decide.
>
> "If you start telling people what to do, you've lost your scientific integrity. It's more important that we just present them with what we consider a valid description of the situation, and let them decide what to do."

He may have been talking about Florida's reefs, but what our editor was really describing was our basic attitude toward our readers.

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Cordially,

Harvey Oshinsky

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NATURAL HISTORY

Incorporating Nature Magazine
Vol. LXXXII, No. 8
October 1973

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Thomas D. Nicholson, Director

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Authors

Ken and Pat Kraft, a free-lance, husband-and-wife writing team, have specialized for twenty-five years in gardening subjects. Their personal experience with gardening led to an interest in Luther Burbank, whose biography they wrote in 1967. Moving to Burbank's adopted California community for a year, they were able to interview several old-timers who knew and remembered the plant breeder. The authors have just finished their tenth book, *Growing Food the Natural Way*.

As a graduate student in anthropology in 1961, **H. Arlo Nimmo** first became interested in the Bajau nomads of the Philippines. He subsequently lived with the tribe for two years, studying the process of their acculturation from sea roamers to land dwellers. Currently an associate professor of anthropology at California State University at Hayward, Nimmo is researching the religion and oral literature of the Sulu province, the Bajau's home.

H. Arlo Nimmo

Since 1956, **R. Cecil Gentry** has flown regularly through hurricanes with the most sophisticated of meteorological instruments and has taken the measure of more than twenty-five storms. Formerly a hurricane forecaster and presently director of the National Hurricane Research Laboratory and of Project Stormfury, Gentry has a Ph.D. in meteorology from Florida State University. When the weather is clear, he turns to the gentle hobbies of gardening, reading, and listening to music.

R. Cecil Gentry

Work on nitrogen balances in apple trees for her doctoral dissertation in plant physiology led **Patricia W. Spencer** to pursue the subject of leaf senescence. An assistant horticulturist at the University of Illinois, she is continuing research in the subject through the use of electron microscopy, enzyme analyses, and nitrogen transport mechanisms. In the future, she plans to concentrate primarily on the movement and storage of nitrogen in the annual cycle of the tree.

Patricia W. Spencer

Using reports gathered by the Smithsonian Institution's Center for Short-Lived Phenomena in Cambridge, Massachusetts, **Daniel Shepard**, a business executive, and his wife, **Jean Shepard**, a free-lance writer, pieced together a description of the tragic 1970 Peruvian earthquake. The coauthors are both concerned with the influence of natural events on contemporary political and cultural affairs. Mrs. Shepard also has a special interest in the contemporary and historical "role of the woman as an individual, mate, parent, and viable member of society."

Daniel Shepard

Jean Shepard

On a research trip to the Ngorongoro Crater of Tanzania to study the wildebeest, **Richard D. Estes** became curious about the resolution of conflict among Grant's gazelle. He has spent five years in various

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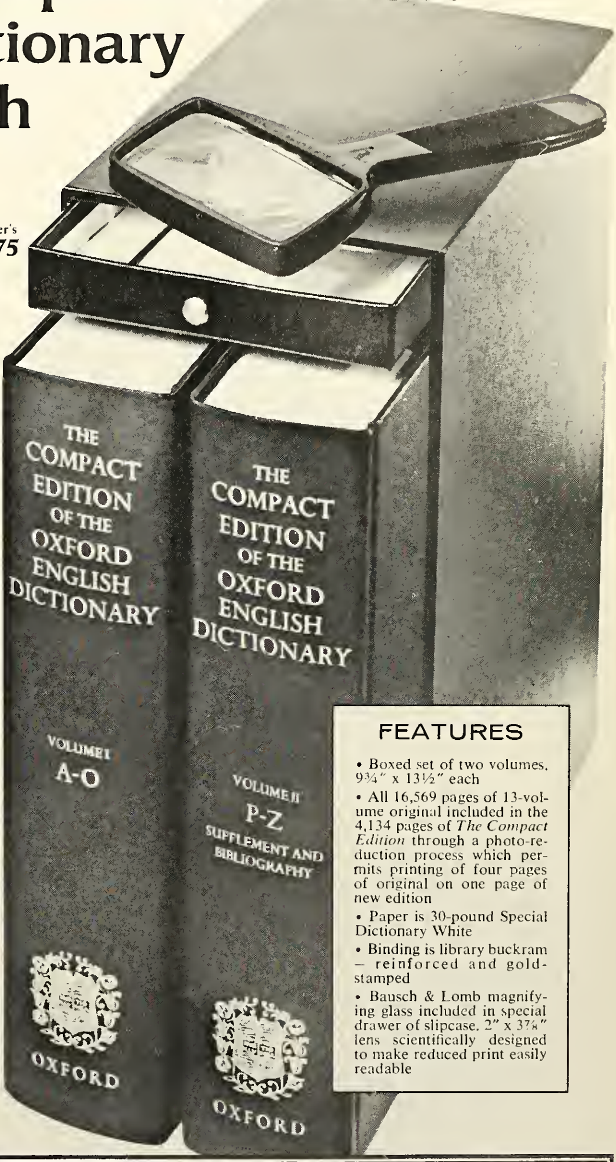
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Richard D. Estes

African countries examining antelope behavior and for the past three years has been writing a handbook on the behavior of some 90 species of African mammals. While pursuing his field studies, Estes was on the staff of Harvard University's Museum of Comparative Zoology. Next year he will join the Academy of Natural Sciences in Philadelphia as Associate Curator of Mammals.

Since his graduation from Trent University in Ontario a few years ago, Andrew Hardy has been traveling and writing. An enthusiastic cyclist, he undertook a cross-Canada trip, was rained out in Alberta, and retreated to the nearest library to write a comprehensive history of the development of the bicycle. He is currently studying nutritional technology, particularly food processing in Victorian England, and will teach a course on edible wild plants at Sir Sanford Community College in Ontario next spring. ☐

Andrew Hardy

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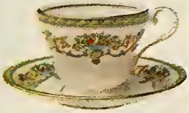

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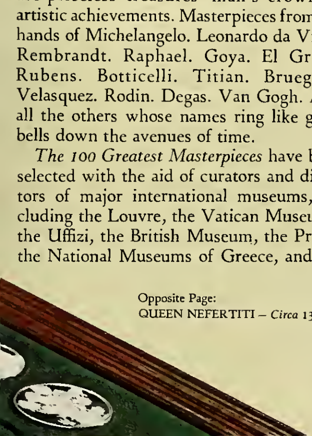

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Letters

Changes on Yap

David Labby's vignette of change in Yapese culture ("Old Glory and the New Yap," June-July, 1973) acquaints readers with some Yapese response to American presence. Care must be taken, however, to avoid falling into the trap of simplistic comparisons and conclusions.

Change comes whether we will it or not. Just a cursory look at human history points to the flow of our species over the planet, bringing with it mixture upon mixture of cultural patterns. The peoples of Micronesia are very much a part of this flow, having affected others as they are being affected today. Let us not sound the death knell for the Yapese so quickly. They are a thriving, proud people.

Howard C. Lerner
Rockville, Maryland

It appears that David Labby's purpose was to attack the policies of the United States rather than to report accurately on the changes in Yapese culture. He says that "many Yapese are finding it difficult to cope with the changing world created by the Americans." How would he change things? I am beginning to tire of anthropologists who think that ancient cultures built on poverty, oppression, and witch-doctor care should be preserved while the rest of the world enjoys medical care, public water, and electricity.

R. F. Wicker, Jr.
Captain, Chaplain Corps, U. S. Navy
Norfolk, Virginia

The Other Genesis

"Genesis," by Salvador E. Luria (June-July, 1973) contained enough fact to make good science fiction, but tended to be too imaginative to be taken seriously.

The irreversibility of evolution and its dependence on "a series of improbable chances that extend back billions of years" were provoking thoughts, but when the author says "a nucleic acid molecule learned to direct the assembly of a protein, which in turn helped the copying of the nucleic acid itself," and some unnamed influence caused "the invention of the cell," he left the realm of fact, substituting pure fancy.

Why is it that man can accept the "invention" of an "enormously complicated" cell, intelligent acids, and scheming genes, but cannot accept the thought of a Being with the power to produce these changes as the result of a plan?

W. P. Davenport
Alameda, California

Salvador Luria is undoubtedly a very learned man, but his article is a confusing hodgepodge of conjectures, riddles, and impossibilities. I prefer the more plausible theory advanced in the book "Genesis."

Howard W. Holschuh
Castleton, Virginia

Research on Bombs

May I heartily disagree with Arthur W. Galston in reference to his comment "and the atomic bomb, which forced Japan's capitulation" ("Hard Times for American Science," August-September, 1973). It has been pretty well documented by now that Japan had capitulated before Hiroshima and Nagasaki and that the use of the atomic bomb was due to pressure in the scientific community to test it out and in the political community to show up the Russians.

I also disagree with Professor Galston's comment that various parts of the coordinated research on the Manhattan District project were "useful." Useful to whom and for what purpose? Those scientists who persist in doing war-related research can always make a case for the usefulness of what they are doing based upon the now totally discredited viewpoint of "national security." What is so useful about coordination of research for greater sources of potential human destruction?

Joyce Kasinsky
New York, New York

Scientists and their Dogs

As a student of canid behavior, I was pleasantly surprised to see Kenneth D. Roeder's article, "A Dog's World View" (August-September, 1973). His casual observations and interpretations were very interesting, and indeed, observations such as these are frequently as important as those conducted under more "scientific" conditions. I should mention, however, that my malamute will dig up an object he has seen me previously bury. For those readers who are interested in another scientist's interpretation of his dog, I recommend the following article: E. S. Russell, "Playing with a Dog," *Quarterly Review of Biology*, Vol. 11, No. 1, 1936.

Marc Bekoff
Department of Psychology
Washington University

Dr. Roeder, have you ever thought that Morris is just plain stupid?

Fred W. Schantz
Greensboro, North Carolina

King Solomon's Hoopoe

In reference to Charles Vaurie's excellent article, "So Fair and Foul a Bird" (June-July, 1973), in Arabic the hoopoe is known as the "hud-hud." It was a bird prized beyond all others by King Solomon, whose pleasure it was to muster the birds every morning at dawn. The birds, for their part, were required to be prompt at roll call.

One morning, however, the hud-hud was absent and Solomon was indignant. Later in the day, the poor hud-hud reported, fatigued but blissful. He had witnessed the enchanting beauty of the Queen of Sheba making her way northward with her retinue from Yemen to meet Solomon.

King Solomon understood. Thenceforth, the hud-hud was greatly favored at court.

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Secrets of the Great Plant

While he used crossing and selection to breed new plants, toward the end of his life Luther Burbank privately attributed much of his success to mystic powers

by Ken and Pat Kraft

In 1922 a young newspaper reporter came to the Santa Rosa, California, home of Luther Burbank to ask the world-famous plant breeder a startling question. Was it true, as rumor had it, that he got his results with new plants by talking to them? Burbank, then a septuagenarian who still worked a ten-hour day, blandly told his interviewer: "That story is too ridiculous for words. You can't accomplish anything by talking to plants or flowers. They haven't any brains." The reporter persisted. He had it on the authority of a reputable horticulturist, he said, that Burbank had produced his famous spineless cactus by oral persuasion.

Of all Burbank's plant developments, the spineless cactus—produced almost two decades before the reporter's query—was the most controversial. Burbank had put it on the market after some dozen years of struggle. It was an overnight sensation. News flashed around the world that Burbank had done it again; he had developed a cactus almost as smooth as a banana, a cheap fodder for cattle, horses, and hogs. Animals ate it readily.

Tests indicated the cactus could yield up to twenty times the tonnage of alfalfa. The prospect of transforming the world's vast arid wastelands into lush cactus pastures suddenly seemed a possibility. More and more kinds of Burbank spineless cacti were bred at the California experimental grounds, including fruiting types that promised human food by the millions of tons. Soon, perhaps, no one on earth would have to go hungry.

Demand was so great that for a while it appeared there might not be enough cactus breeding stock to go around. Jack London, a personal friend and neighbor of Burbank's, planted spineless cacti on his cattle ranch at nearby Glen Ellen. Cactus dealerships, geared for worldwide sales, sprang up. The Southern Pacific Railroad planned to plant the new cactus on some of its acreage in southern California and Arizona. In India British officials ordered trial plantings in the subcontinent, with a view to ending famines.

Before he was done with it, Burbank had produced sixty or more varieties of spineless cacti. The money he got from the sale of only five of them—to an Australian nurseryman for exclusive breeding and distribution rights in the Southern Hemisphere—almost paid for his new house. He was the cactus king of the world. Then the climate of opinion started to change.

United States Department of Agriculture scientists and various university agronomists began to discount the nutritional value of cactus. They questioned its growth in unfavorable climates and labeled it impractical for range conditions. Although each of these objections had some merit, the criticism did not entirely discredit the plant's value. But some of Burbank's cacti had gotten into the hands of overzealous promoters whose exaggerated claims killed whatever future the cacti once had. Burbank's faith in his cactus continued for the rest of his life, but except for the acclaim he won for having bred away so permanent-seeming a trait as the spines, his cactus project was a humiliating personal disaster.

And now this young interviewer was trying to open the old wounds. Burbank stared briefly at him, then leaned back in his rocking chair and laughed—for fully a minute, the reporter later said. "I suppose," Burbank remarked of the anonymous horticultural authority, "he claimed I threatened to sit on the cactus plant if it didn't obey me." He then dismissed the subject by changing it.

Burbank had his reasons for side-

Wizard

stepping the reporter's questions about his rumored ability to communicate with plants. It was a subject he discussed with very few people. But the truth is, Luther Burbank was sure that plants could understand him. Considering his record, it is easy to see why.

Burbank did most of his plant experimentation in his four-acre garden in Santa Rosa, California. Among the best-known of the many hybrids he developed during his fifty-year career are the Burbank potato, the Shasta daisy, and a white blackberry. His experiments with plums changed the growing of these fruits on the West Coast.

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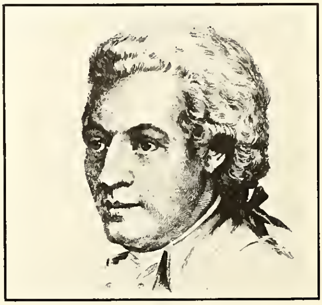

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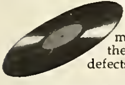

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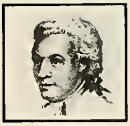

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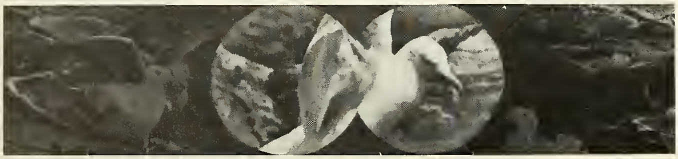

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The spineless cactus, developed for forage, is sampled by Burbank, an assistant, and the yogi Paramahansa Yogananda, an admirer.

During his fifty-year-long working life, Burbank created more than 800 new strains, varieties, and species of plants—most of them useful. If these plants, never seen on earth until he coaxed them into existence, had been spaced out evenly over those fifty years, they would have arrived at the rate of one brand-new plant every three weeks. According to a contemporary geneticist at the United States Department of Agriculture, Burbank advanced the art of plant breeding by two entire decades. In his own day he was called the "wizard of horticulture," and he remains the only horticulturist in history whose name was recognized all over the world. His achievements are all the more re-

markable because of his lack of formal scientific training. He attended public schools and a prep school in Lancaster, Massachusetts, where he was born in 1849. The rest of his education came from scattered reading and observing plant life on a farm.

In his outstanding career, his personality was one of Burbank's most telling assets. Because he was heavily dependent on publicity—word-of-mouth and otherwise—to sustain him in business, it was fortunate that he was a man of immense personal charm, an obliging person always good for a story when called on by reporters. He was nimble minded and interested in all sorts of everyday things—singing, machinery, wood carving, child rearing, home remedies, bicycling . . . none of them outside the average man's experience. It was his very averageness, in fact, that obscured Burbank's unscientific and unorthodox belief that he actually did communicate with plants. But when it came to talking about this conviction, there were two groups of people—journalists and professionals in his own field of science—

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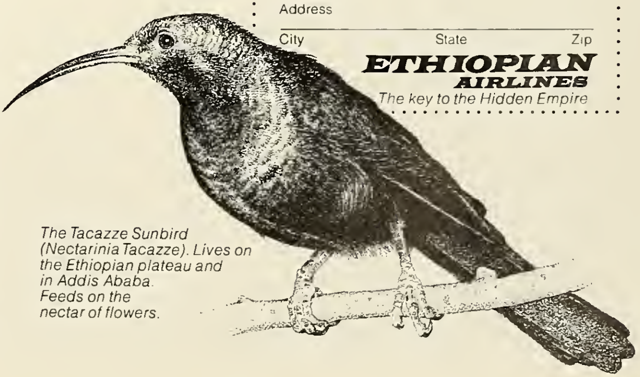

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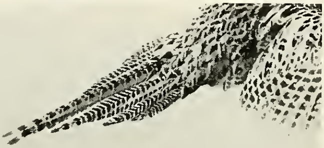

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to whom Burbank never admitted his belief.

In 1904 one of the world's great botanists, Hugo de Vries of the University of Amsterdam, visited Burbank to find out how he had been able to do things with plants that no other expert had been able to match. Although Burbank was his usual personable self, de Vries learned no secrets. De Vries subsequently wrote a detailed study of plant breeding that dealt in part with Burbank's experiments but contained not the slightest suggestion that Burbank had confided his belief in a literal communication with plants.

Another example of Burbank's wariness about revealing to scientists his communion with plants was the failure of the Carnegie Institution to publish a definitive report on Burbank's unique ability at plant manipulation. From 1905 through 1909, the Institution granted Burbank a subvention of $10,000 a year and assigned a leading geneticist, George H. Shull, to study Burbank's methods and results in Santa Rosa. Despite the professionally intimate relationship that resulted, there was never any intimation that Burbank told Shull of his belief in the control of plants through power of suggestion. It may be argued that perhaps Burbank did confide in Shull, but that the Carnegie Institution could not bring itself to dignify so bizarre a situation by giving it official recognition. This, however, seems doubtful, if only because an objective scientific report on Burbank would include any unorthodox mental attitudes as a routine part of the study.

Despite his reticence concerning communication with plants, Burbank showed no similar reserve in making public his belief in extrasensory perception, a phenomenon that had already gained some serious scientific attention.

"My mother's brain was both a transmitting and receiving radiotelephone instrument," he wrote in 1923 in *Hearst's International* Magazine. "I inherited my mother's ability and so did one of my sisters." This sister, Emma, lived in a town about sixteen miles north of Santa Rosa; their mother made her home with Burbank. The mother lived to be 96, and during her last years, Burbank said, whenever the old lady felt unwell, he

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would summon his sister by telepathy alone. Emma, he claimed, always arrived on the next train. Burbank considered this quite normal. "I believe we all have been broadcasting and receiving from the beginning of human thought," his magazine article continued. "Those who can send messages to particular persons differ from the others only in that they can direct their thought waves where they wish them to go. The greater part of humanity simply broadcasts."

A rationalist to the core, Burbank tried to prove his point by a physical comparison: "Thoughts are unquestionably produced by discharges of electrical energy. Radio messages are sent by discharges of electrical energy. The two things are the same—except that the human machine is infinitely more wonderful and capable of incomparably greater achievement."

The following year, 1924, in an article he wrote for another popular magazine, Burbank included dogs in the telepathic circuit: "[They] not only can understand a good deal that we say, but by a peculiar kind of subconscious telepathy they receive a great many of our thoughts. Bonita [the crossbreed he and his wife cherished] likes and dislikes the same kinds of persons that we do."

More than most people, Burbank had reason to believe in telepathy, for he enjoyed a remarkable kind of luck in his work. This was the frequency with which he would find in the mail rare seeds or plants that were exactly what he needed for a current experiment. They came from strangers who often lived on the other side of the earth and could only have known what he happened to want at the moment through some such atypical agency as telepathy. These coincidences took place so often that Emma Burbank was moved to remark that her famous brother grew so used to them, he was surprised when they didn't occur.

During the last few years of his life, Burbank had three notably significant discussions about his plant-communications theory. Conversing in his garden with Helen Keller in 1925, he gave that famous and highly intuitive woman the impression a telepathic association existed between himself and plants. She

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later wrote in the magazine *Outlook for the Blind:*

"He has the rarest of gifts, the receptive spirit of a child. When plants talk to him, he listens. That is why they tell him so many things about themselves. Only a wise child can understand the language of flowers and trees. Mr. Burbank feels the individuality, or genius of the plant—that something which invents, changes, urges, and adds or drops characteristics as the plant advances. So he encourages the plant to put forth the best of which it is capable."

In a second discussion held the same year, Burbank's audience was a young minister, Manly P. Hall, who later founded the Los Angeles-based Philosophical Research Society. Hall reported that Burbank told him he kneeled and talked to his plants when he wanted them to develop in a new way and that while man had only five senses, he believed that plants had more than twenty. Because these plant senses are different from ours, Burbank stated, humans do not recognize them.

"He was not sure that the shrubs and flowers understood his words," Hall related some years later in a 1959 issue of his research society's journal, "but he was convinced that by some telepathy, they could comprehend his meaning." This has the ring of authenticity. "To Burbank," Hall wrote elsewhere, "the secret of plant breeding was summarized in a single word: love. This power, greater than any other, was a subtle kind of nourishment that made everything grow better and bear fruit more abundantly. He explained to me that in all his experimentation he took plants into his confidence . . . asked them to help, and assured them that he held their small lives in the deepest regard and affection. He insisted that this was the secret of his green thumb. . . ."

Burbank had also recounted much the same thing to a teen-age family friend and temporary employee who clearly remembered the conversation sixty years later after retiring from a career as a judge on the Sonoma County Superior Court bench. With a youngster's curiosity, the lad had asked Burbank, who made extremely sketchy notes, how he managed to keep track of thousands of experiments all going on at

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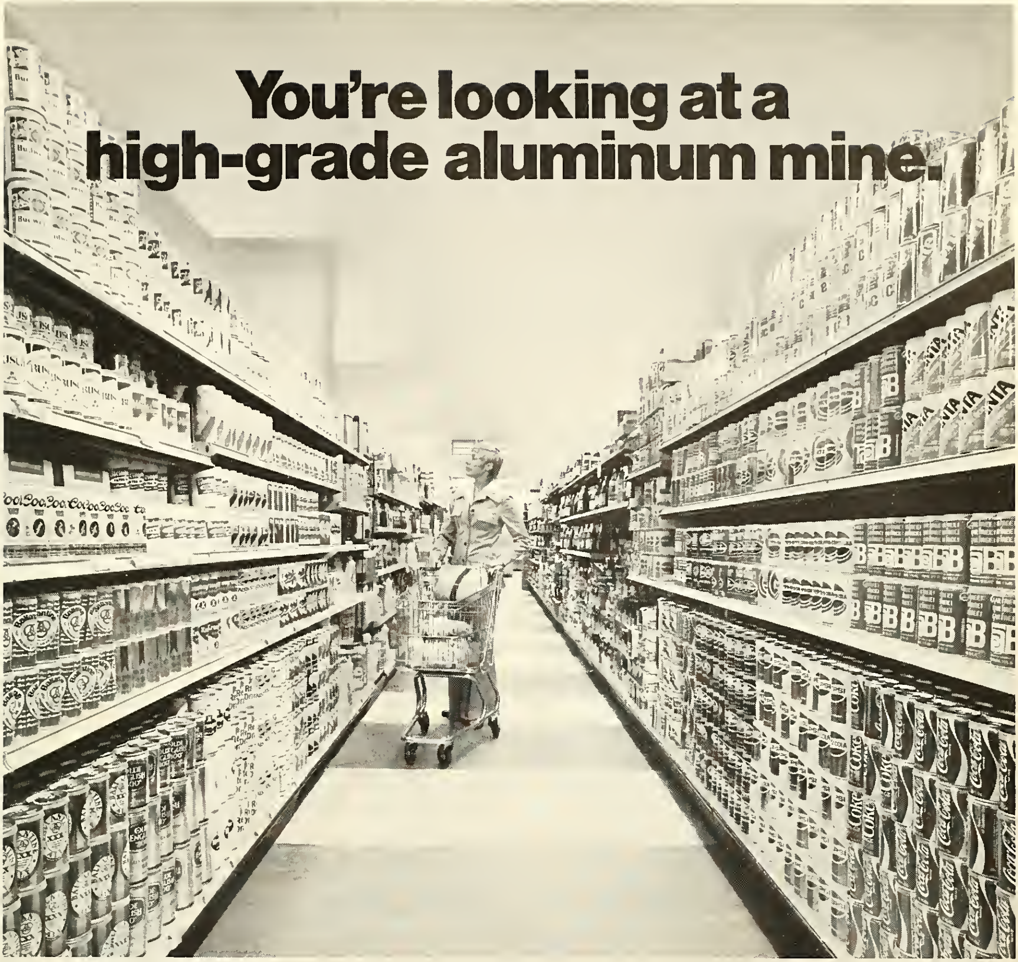

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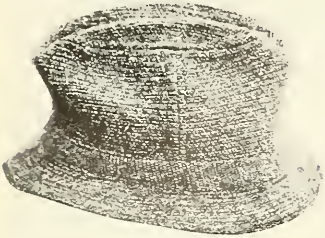

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the same time. Burbank said, "I do it with love. . . . I feel an affection for everything I am working with, and so I can keep in touch with everything that concerns them." The conversation took place in 1905, the first year of the Carnegie Institution's five-year study of Burbank's methods.

Two years before his death in 1926, Burbank had a long talk with a then well-known yogi, Paramahansa Yogananda. To this mystic he confided a good deal. In fact, the picture that the Yankee-born businessman-horticulturist drew of himself is little short of bewildering. Yogananda was sufficiently impressed by Burbank's confidences to make a detailed report of them in his widely circulated autobiography, which was dedicated to the horticulturist.

Burbank had started by saying that his mother had reappeared and spoken to him several times since her death. He then discussed Kriya Yoga, a technique for the supposed mental control over physical functions that he was studying. Yogananda defined the process this way in his book:

"*Kriya Yoga* is a simple, psychophysiological method by which human blood is decarbonized and recharged with oxygen; the atoms of this extra oxygen are transmuted into life current to rejuvenate the brain and spinal centers. By stopping the accumulation of venous blood, the yogi is able to lessen or prevent the decay of tissues. The advanced yogi transmutes his cells into energy. Elijah, Jesus, Kabir, and other prophets were past masters in the use of *Kriya* or a similar technique, by which they caused their bodies to materialize or dematerialize at will."

According to Yogananda, Burbank said in their interview, "I practice the technique devoutly," and further remarked, "Sometimes I feel very close to the Infinite Power. Then I have been able to heal sick persons around me, as well as many ailing plants." Burbank always had felt he possessed a mysterious healing power. His technique was the laying on of hands combined with suggestion, through which he claimed to have restored to health, among others, a housemaid, a dying neighbor, a victim of

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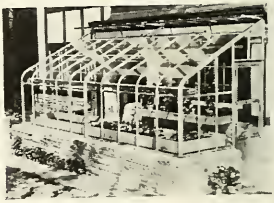

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appendicitis, and an incipient madman.

Although two years earlier Burbank had scoffed at the newspaper reporter's question of whether he talked to plants, he admitted as much to the yogi. "While I was conducting experiments to make spineless cacti," he told Yogananda, "I often talked to the plants to create a vibration of love. 'You have nothing to fear,' I would tell them. 'You don't need your defensive thorns. I will protect you.' "

There is, of course, the possibility that Burbank has been misquoted or that words were put into his mouth. But the accumulated weight of evidence pointing to his

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belief in communication with plants is too great to be dismissed. Still another indication of this belief was a tendency toward anthropomorphism. "The most stubborn living thing in this world," he stated in his writings, "the most difficult to swerve, is a plant once fixed in certain habits. . . . Remember that this plant has preserved its individuality all through the ages; perhaps it is one which can be traced backward through eons of time in the very rocks themselves, never having varied to any great extent in all these vast periods. Do you suppose, after all these ages of repetition, the plant does not become possessed of a will, if you so choose to call it. of unparalleled tenacity?"

Burbank also liked to say of plants that he "educated" them to do the things he wished them to do. Flatly contradicting his 1922 statement, "they haven't any brains," he wrote four years later in *Popular Science Monthly:* "There is no great gulf between plant and animal life. I know that plants have minds—subconscious minds, but at any rate, minds."

In April, 1926, one month after that pronouncement appeared, he died. It was five weeks after his 77th birthday. By then his beliefs had come full circle: not only were plants very much like animals, but people, he concluded, were like plants. As he had told Yogananda, "I see humanity now as one vast plant, needing for its highest fulfillments only love, the natural blessings of the great outdoors, and intelligent crossing and selection. In the span of my own lifetime I have observed such wondrous progress in plant evolution that I look forward optimistically to a healthy, happy world as soon as its children are taught the principles of simple and rational living. We must return to nature and nature's God."

In the secret world of Luther Burbank, nothing was impossible if one tried long enough and wished hard enough. He believed that the human brain transcended space and that plants understood his wishes. Now, nearly a half century after his death, no one has offered a convincing explanation for many of the things he was able to do. And, interestingly, his philosophy of living in peaceful partnership with nature is back with us in new strength. ☐

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The farm crops of the world differ tremendously in their rates of growth and total yield per acre. Grasses of tropical origin, like sugarcane, sorghum, and maize, have the highest recorded yields, frequently more than twice that of such other important crop plants as soybeans. Why the difference? In a world in which food production has difficulty keeping pace with the needs of increasing numbers of hungry people, the question is of more than theoretical interest. Some exciting clues have been uncovered in the laboratory in the last few years that may ultimately lead to improved plant productivity in the field.

The two basic processes to consider are photosynthesis and respiration. In photosynthesis, light energy captured by chlorophyll-containing bodies in the cells of green plants is used to form sugar and oxygen out of carbon dioxide from the air and water from the soil. The immediate photosynthetic product, sugar, contains the absorbed energy in a stored chemical form. Some of the sugar is subsequently transformed into the other organic materials in the plant, such as starch, cellulose, fat, protein, and vitamins. These various materials, when consumed by animals, become both the energy source and the basic building blocks for all higher creatures, including man.

In respiration, the energy bound up in the sugar molecule is released. This process, common to all cells—plant and animal alike—involves the oxidation of sugar to yield carbon dioxide, water, and energy. Respiration is essentially the reverse of photosynthesis although it takes place in all cells continuously, day and night, whereas photosynthesis proceeds only in green cells and only in the light.

The productivity of a plant can be measured by comparing the amount of photosynthesis, by which it creates organic matter, and its total amount of respiration. For a plant to grow rapidly, it must capture much more energy during periods of light than it uses for respiration in light and darkness.

In the presence of light, plants release much less carbon dioxide through respiration than they absorb by photosynthesis. Under optimal conditions, the rate of photosynthesis can be up to twenty times as rapid as the rate of respiration in a green cell. The standard laboratory technique for estimating the true rate of photosynthesis in a green cell has been to measure the rate of carbon dioxide fixation in the light and then correct that figure for carbon dioxide lost by respiration in the dark.

That simple correction, although valid logically, turned out to be biologically misleading. It assumes that the respiratory rate as measured in darkness is the same as the respiratory rate in the light. About fifteen years ago, however, it was noticed that when laboratory plants in the dark are suddenly exposed to light, they release a gush of carbon dioxide, obviously from some chemically bound form of the gas in the leaf. This process involving the extra yield of carbon dioxide in the light was named *photorespiration.*

Agricultural researchers became interested in the process when they discovered that photorespiration can release as much as half the carbon dioxide fixed by a plant. Such photorespiration was undoing the beneficial effects of photosynthesis. Furthermore, it was learned that high-yielding plants tend to have low rates of photorespiration, and vice versa. This suggested that photorespiration wastes a plant's energy and that if the process could be modified in an inefficient crop like soybeans the rate of carbon dioxide fixation, and therefore ultimately of crop growth, could be increased. This has turned out to be more difficult to accomplish than to theorize about, but significant progress has been made.

The first important question, "What is the source of the carbon dioxide involved in the photorespiratory gush?" was answered relatively quickly. Conventional tracer experiments with radioactively labeled carbon showed that much, if not all, of the released carbon dioxide came from the oxidation of a simple substance called *glycolic acid.* Glycolic acid oxidation probably does not occur in significant amounts during normal respiration in darkness. When a light is turned on, however, the process begins, and its release of carbon dioxide partly negates the photosynthetic fixation of the gas, which also starts when the light is turned on. Must these two light processes—one favorable to plant growth and the other apparently detrimental—necessarily go on together? Is there some possibility that photorespiration might be slowed down or eliminated without harming the plant?

One approach to deleting or diminishing the reaction would be to use genetic techniques to select and breed strains of plants that have low photorespiration rates; another would be to find a chemical substance that would inhibit glycolic acid oxidation without affecting the rest of the plant's respiration. (Respiration is, after all, required for continued energy release; it would be counterproductive to stop it entirely.) Both approaches have been tried with partial success. In particular, an inhibitor called alpha hydroxy pyridine methanesulfonic acid (HPMS for short) substantially decreases glycolic acid oxidation when sprayed on plants. HPMS also causes glycolic acid to accumulate in the plant. This glycolic acid buildup is ultimately converted to stored plant materials with the overall effect that carbon dioxide fixation in the light is increased two- to fourfold. These results have so far been accomplished only in the laboratory, but it is believed that they can be matched in the field to increase plant yield.

The environment can also be manipulated to lower the rate of photorespiration. At the moment, such methods are laboratory tricks, not applicable to field agriculture, but they might be effective with crops currently grown in greenhouses and, in the future, used for crops raised under plastic bubbles. One laboratory technique employs temperature moderation. Photosynthetic carbon dioxide fixation in a plant like corn, which has a very low rate of photorespiration, increases progressively when the temperature is raised to about 97°F. On the other hand, carbon dioxide fixation in wheat, which has an active photorespiration rate, may actually decrease when the temperature is raised. These opposite effects occur because the rate of photorespiration accelerates more with a rise

Continued on page 32

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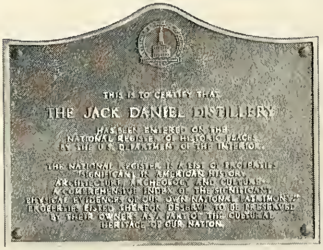

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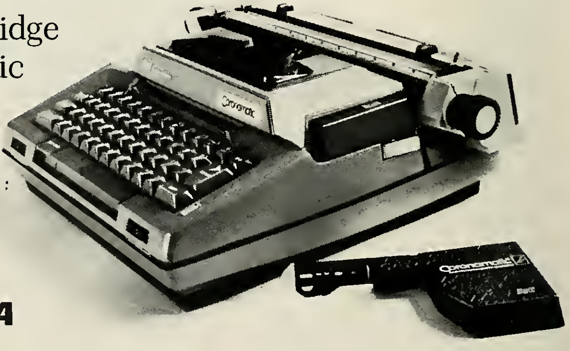

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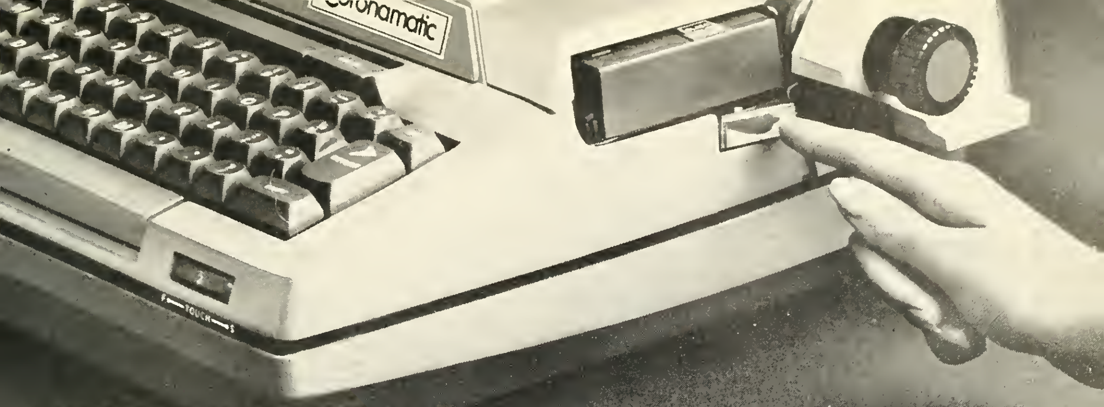
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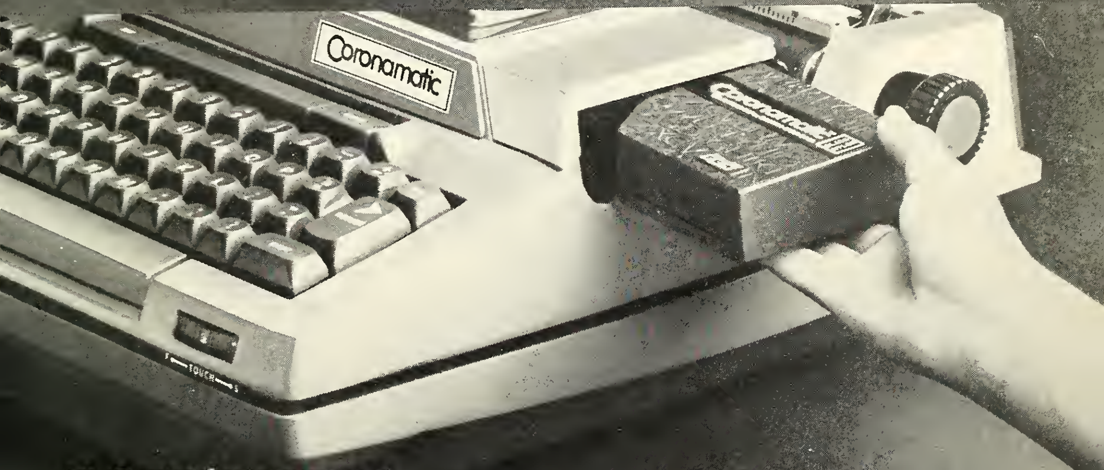
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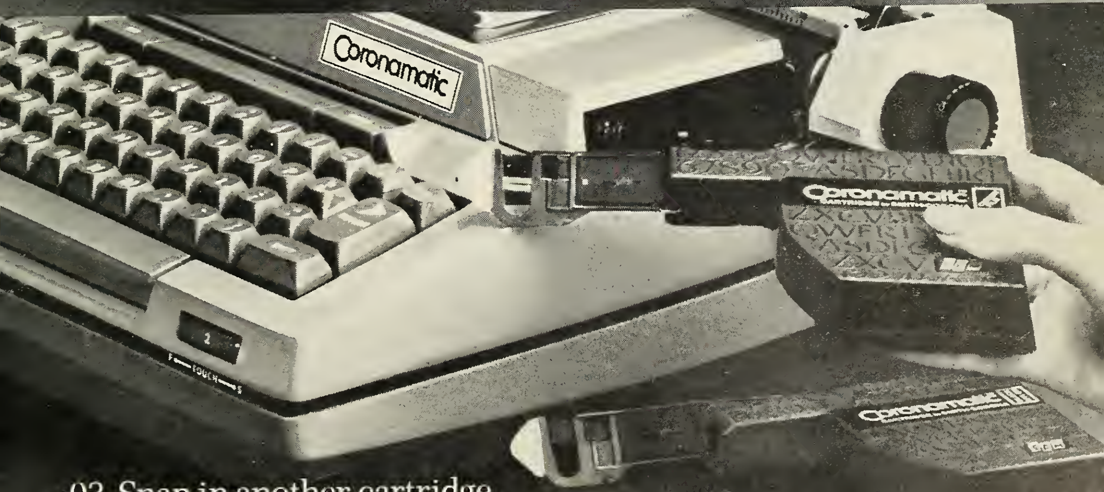
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Continued from page 29

in temperature than does the rate of photosynthesis. Thus, raising the temperature of some plants can induce higher yields, whereas lowering the temperature of others induces a parallel result. This fact may account to some extent for variations in the efficiency of different plants at different latitudes and could possibly be used for crop control in the future.

Another approach stems from the observation that the photorespiration rate mounts progressively as the amount of available oxygen increases all the way up to an oxygen concentration of almost 100 percent in the air surrounding a plant. Since photosynthesis is not similarly affected, net carbon dioxide fixation and crop yield decline as oxygen concentration rises. This suggests that decreasing the oxygen content below the 20 percent level found in ordinary air might decrease photorespiration and improve the growth of some plants. This actually works out in practice. Soybean plants, for example, grow much more lushly in an atmosphere of 5 percent oxygen than they do at 20 percent, and they produce the same number of flowers and pods. But so far an unexpected result has precluded a better harvest. When the pods are opened up, the seeds—the most valuable part of the harvest—are found to have aborted or failed to fill out. It appears that some system important to seed development requires the higher oxygen concentrations. To realize the benefits of this experiment in plant growth, the oxygen level should therefore be lowered only during the vegetative or preflowering stage. Once flowering has occurred, oxygen concentration may have to be raised to atmospheric levels for normal seed development.

These and other experiments with photorespiration have introduced us to some of the complexities of plant energetics and growth. Future efforts will lead us to more theoretical knowledge about these processes and may point to methods for increasing food for mankind. Undoubtedly such frustrations as the stunted soybean seeds will recur, but some of the many experiments under way may show better results. At this point, prospects are hopeful. ☐

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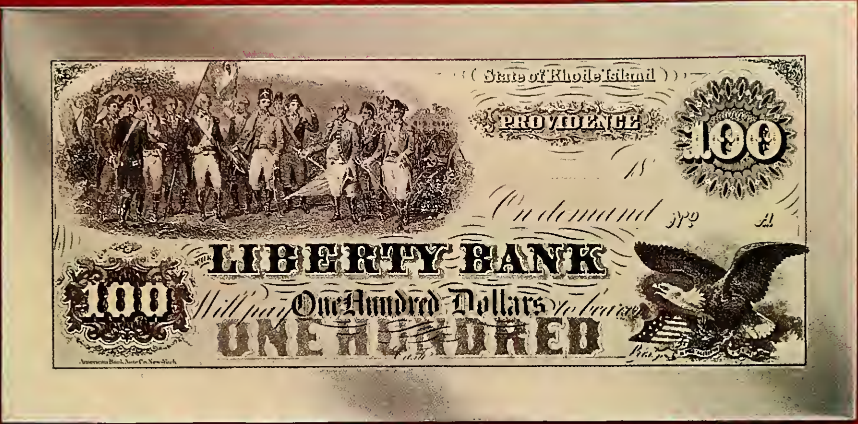

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A Tribe of Ancient Mariners Comes Ashore

Living half-on, half-over coral reefs, the Bajau of the Philippines are always prepared to return to the sea

by H. Arlo Nimmo

photographs by Ted Spiegel

In 1903, an American visitor to the islands of the Sibutu Group described them as the "most God-forsaken" in all the Philippines. Overlooked when the international boundaries were drawn, they now appear on the map as a jagged little knob at the southwest end of the Philippines, 22 miles from Borneo. In these remote islands—almost unnoticed by the rest of the world—a community quietly grew out of the sea, evolving from a handful of houses and boats on the shoreline of

tiny Si Tangkay Island to a bustling commercial center of 3,400 people.

Certainly communities have grown faster and larger elsewhere in the world, but Si Tangkay is unique in that it grew entirely over the sea. Of its present inhabitants, two-thirds are Bajau who formerly lived nomadic lives in small houseboats. During the decades since World War II, however, these sea folk have been integrated into the mainstream of life in the Philippines. The change has been rapid and easy, making the case of the Bajau somewhat different in a world where ethnic minorities are usually either brutally eliminated or forcefully incorporated into dominant societies.

The Bajau of Sulu Province in the southern Philippines are but one of several groups of nomadic boat-dwelling peoples scattered throughout Southeast Asia. Other sea nomads have been reported in parts of Indonesia, southern Malaya, and the Mergui Islands of Burma. Although the historical relationship of these different sea peoples is still unknown, little doubt exists about the close relationship of the several enclaves of Bajau in the Sulu Islands. These groups all speak dialects of the Samal language, share many cultural features, and were until recently predominantly boat dwellers. Throughout the Sulu Archepelago, the Bajau represent a small minority of the total population; for example, they constitute only 4 per-

cent of the Tawitawi Islands' population. In the Sibutu Group, however, they make up 23 percent of the population of approximately 12,000.

For unknown years, the Bajau have plied the Sulu waters in their small houseboats. Magellan's chronicler saw them when he visited the Zamboanga Peninsula in 1521 and noted that "the people of that island make their dwellings in boats and do not live otherwise." Actually, most of the people on the peninsula lived on land, but he was correct in noting that some, namely the Bajau, spent their entire lives on the sea. Various groups of Bajau lived throughout the Sulu Archipelago, each group identified by the cemetery island where it buried its dead. The burial island, around which several flotillas moored, served as a focal point for the nomadic Bajau as they followed the monthly and yearly cycles of the fish. Local environments and individual preferences determined—and still determine—the nature of Bajau fishing. Today, some Bajau families leave their home moorings each month and spend a week to ten days on certain reefs that become lucrative fishing grounds during flood and neap tides. Others rarely fish overnight away from home.

The nature of Bajau contacts with the Islamic land dwellers varied somewhat throughout the archipelago, but for the most part the relationship was symbiotic, the Bajau trading fish and sea products for the agricultural produce of the land dwellers. The Moslems considered the sea people outcasts, filthy pagans cursed with a life unblessed by Islam. Consequently, apart from trading, social interaction between the two groups was almost nil.

The floating homes of the Bajau, which usually housed a single family, were planked dugouts, sometimes with double outriggers, ranging from twelve to perhaps sixty feet in length with a beam of no more than two to five feet. Built upon this hull, the frail house structure, consisting mostly of a nipa roof, was as long as thirty-five feet on the larger boats or as short as six feet on the smaller craft. Generally, the house was no higher than four or five feet at the gable and seldom more than six feet wide. On most boats the house structure could be easily taken down and a sail erected when long distance travel was necessary. Elaborate curvilinear carvings of stylized birds, fish, and flowers decorated the sterns and bows.

Although the family did a great deal of traveling among the various houseboat moorings, it always identified one as its home. Occasionally, a family joined the married siblings of either the husband or wife to form a second important social unit in the boat-dwelling society, the family alliance unit, which functioned primarily in fishing, ceremonies, and other activities requiring group effort. Each mooring was made up of several such family groups and formed a community of related persons with an older man acting as headman. At the larger moorings there were several such kin groups, and the headman of the kin group that first moored there served as headman for the entire mooring. No formal political organization existed beyond the mooring level, but because of the many kin ties and frequent movements among the several moorings, they constituted a single, albeit dispersed, Bajau community. There were probably about ten such communities in Sulu at the turn of the century.

Today, only some of the Bajau of the Tawitawi Group still follow the boat-dwelling tradition, while throughout the rest of Sulu the Bajau have almost entirely abandoned full-time boat living in favor of pile dwellings built on coral reefs or island shores. Among the most confirmed house-dwelling Bajau in Sulu are those of Si Tangkay, the southernmost port in the Philippines.

It is difficult to pinpoint any single reason why the Si Tangkay Bajau moved to houses; rather, a series of interacting events at appropriate times seems responsible for

Bathing, left, is one of the most frequent pastimes of many tropical island-dwelling people, including the Bajau. Because they are easier to handle and tend to shorten fishing expeditions, outboard motors have made the use of sails, right, less commonplace.

the movement. Si Tangkay was originally a Bajau burial island. The Bajau were apparently first attracted to the island at the beginning of this century when a Chinese fish buyer established residence there, offering a ready market for their fish in return for essential manufactured items, such as clothing, fishing supplies, matches, and tobacco. The island was ceded to the United States in 1900, and American administrators arrived soon after to usher in a period of relative peace and stability, a rare phenomenon in Sulu if earlier sources are to be believed.

The northern islands had long been battlefields for countless conflicts between the Spaniards and Moslems, but even before the arrival of the Spaniards in the sixteenth century, Sulu history was heavily punctuated by petty wars between local leaders attempting to usurp one another's power. Add to these hostilities the piracy endemic to the islands for centuries and the occasional slave-raids from Borneo, still remembered by some Bajau old people, and one gleans some notion of the hostilities of the area. These factors, coupled with their migratory fishing habits, encouraged the Bajau to live in boats away from the larger islands, which were probably already inhabited when they arrived in the area. Under American administration Si Tangkay became a relatively safe and convenient place to live, so Bajau houseboats began mooring there regularly as they rested from fishing. Intimate social contacts with the Moslems who had moved there, as well as Si Tangkay's new cash economy, encouraged some Bajau to experiment first with house living and then with Islam. House living and Islam had always been the hallmarks of their social superiors, and those first few ambitious Bajau saw in them an escape from their traditional outcast state and grasped the opportunity. Their success spurred others to follow suit, and by 1940 a dozen or so Bajau families were living in houses. The outbreak of World War II and the establishment of a Japanese military installation on Si Tangkay Island drove the Bajau back to their houseboats, and they dispersed to the outer reefs and islands for the duration of the war. With the cessation of fighting, the Bajau returned to Si Tangkay, and again a few families experimented with house living. Others soon followed with the consequence that boat-dwelling Bajau have now almost vanished from the Sibutu waters.

Today Si Tangkay, a unique spot in the Philippines, is "blessed" with almost everything a community should *not* have. The island has no drinking water, so all water must be collected during the rains or transported from the brackish wells of Sibutu Island during droughts. Since two miles of shallow reef water separate the town from the wharf, all goods must be moved to and from the large ships in small boats. Low tides expose the surrounding reefs, completely isolating the community from sea traffic. And, finally, infertile soil on Si Tangkay Island discourages any agriculture other than copra production, thereby necessitating the importation of all agricultural products, mostly from Tawitawi.

Nevertheless, promoters of tourism have labeled it the "Venice of the Philippines," and, although not quite Venice, Si Tangkay perhaps warrants the appellation. A main canal, the continuation of a shallow channel that cuts through the reef, divides Si Tangkay's population of 3,400 roughly in half. Two-thirds of this population is Bajau, while the second largest group is the land-dwelling Moslems, followed by the Chinese and the Christian Filipinos. In recent years coral walkways, connected by two elevated bridges high enough to allow the passage of

Their constant squatting position, left, has rendered some of the older, boat-dwelling Bajau incapable of standing upright. In a Si Tangkay residential area built over coral reefs, right, extended families crowd small houses lining the canals.

small motor launches at high tides, have been constructed on either side of Si Tangkay's main canal. A large, roofed deck adjoins one of the bridges, providing Si Tangkay's elevated counterpart of the village plaza. On either side of the canal, nearby houses built on piles over the shallow reef waters are connected by a maze of bridges and boardwalks, while more distant, unconnected houses depend upon small boats for access to the main part of town. A few shops are housed in the original land structures built by the Chinese, but most are scattered on either side of the canal, closer to the rest of Si Tangkay's population. The village boasts two mosques: one for the Bajau, who have retained much of their traditional religion; the other for the non-Bajau, who feel they practice a more orthodox form of Islam. Four branches of a public school offer instruction through the sixth grade. A small post office and a telegraph office keep the community in occasional touch with the outside world. The terrestrial roots of some non-Bajau inhabitants are revealed in the small gardens planted on man-made islets of coral stone and earth transported from neighboring islands. Others are content with patios of potted plants. A few enterprising individuals, mostly Chinese and non-Bajau, have capitalized on Si Tangkay's water shortage by constructing large concrete storage tanks. Water stored during the rainy periods is sold during the droughts.

The shallow sea beneath Si Tangkay is a playground for the children, who learn to swim almost as soon as they learn to walk. In addition, it is a highway for boats, which move through the waters all day and into the night. Some carry fishermen peddling their catches, others transport persons en route to dwellings unconnected by bridges, women hawking freshly baked cakes, or farmers from neighboring islands selling fruits and vegetables. Children dart about in their own

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small boats. Only when the tide goes out and the reef floor is exposed does the boat traffic cease.

Serving as the administrative and commercial center of the Sibutu Group, Si Tangkay has an economy based almost exclusively on fishing. A few Bajau are engaged in small businesses, but in general, they are fishermen who sell their catches to middlemen, mostly Chinese, who ship them to retail outlets in the northern provinces.

Almost all the Si Tangkay Bajau are nominal Moslems, the degree of orthodoxy varying greatly among individuals and kin groups. A Bajau headman, now deceased, who built the first permanent Bajau house in Si Tangkay after World War II, also built the first mosque for Bajau. Before starting the mosque, he sent his young son to Tawitawi to learn Islamic ritual from an imam who had befriended the family some years earlier. With the son's return and the assistance of friendly Moslems of Si Tangkay, the Bajau family learned Islam. Other Bajau, observing the family's metamorphosis from outcast pagan boat dwellers to respectable Moslem house dwellers, were sufficiently impressed to join the new Islamic Bajau community. Today almost every Si Tangkay Bajau lives in a house and attends the mosque at some time during the year to observe the various Islamic celebrations. Three Bajau men have made the holy pilgrimage to Mecca and consequently hold the title "hadji," with its accompanying status and respect.

The Islam of the Bajau, of course, contains elements of their traditional religion. In fact, they have simply added Islam to their native religion. The result is a colorful and complex, but compatible, set of religious beliefs. Shamans attend the mosque and assist imams with Islamic ritual. Ceremonies at birth, marriage, and death combine elements of both religions. The Islamic Allah is the object of worship in the mosque, but certain islands near Si Tangkay house small shrines, where offerings are left for indigenous, non-Moslem spirits. As the Bajau become more knowledgeable about orthodox Islam, they will probably abandon many of their traditional religious practices, but for the present the two religions are happily syncretized into a colorful folk Islam.

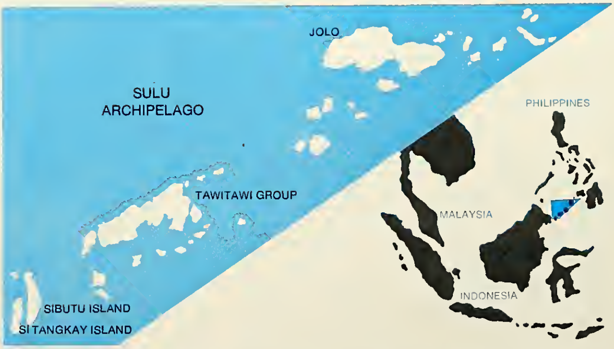
A host of other changes have come to the Bajau with their greater participation in the dominant Sulu culture. Whereas loincloths for men and waist sarongs for women were standard garb for the boat-dwelling Bajau, the house-dwelling males prefer Western styles, while the women wear traditional Sulu styles. Dietary habits have also changed. Greater cleanliness in the preparation of food is evident among the Si Tangkay Bajau, as well as greater experimentation with new foods.

The boat-dwelling Bajau of Tawitawi are extremely conservative in their eating habits; their diet consists mainly of fish and cassava with occasional fruits when they can be obtained from land dwellers. In Tawitawi the Bajau have only recently been coaxed by a Catholic priest to send their children to school, but few attend regularly. Parents see no value in formal education, and the fishing cycles demand that the family periodically leave the mooring where the school is located. At Si Tangkay, however, formal education has become a part of the cultural pattern. Bajau children regularly attend the public elementary school—in fact, one of the teachers is a young Bajau.

Changes in sexual behavior among the Si Tangkay Bajau can be partly attributed to their participation in the Islamic cultural patterns. Prostitution is unknown among the boat-dwelling Bajau of Tawitawi, and there is no reason to doubt informants' claims that it was unknown among the Si Tangkay Bajau before they adopted house living. Prostitution is rare among the Islamic peoples of Sulu, and most prostitutes in the islands are reportedly non-Moslems.

Among the Moslem peoples of Sulu premarital sexual relations are strongly tabooed and when discovered often lead to litigation, perhaps a heavy fine, or maybe even a family feud. Female chastity is highly prized, and a young girl who loses her virginity will command a lower bride price as well as lower status for herself and her family. Such is not the case with the traditional boat-dwelling Bajau. A great deal of premarital sexual behavior is condoned among young people, and female chastity is not highly valued. Youths are expected to experiment with sex before marriage and most do. When two societies with such

The availability of ready markets for their catches of fish is one reason the Bajau have become land dwellers on islands that once served only as burial grounds and moorings for family groups.



differing views of premarital sexual behavior come into intimate association, it is perhaps understandable that the men of the society (that is, the Moslems) who are denied premarital sexual access to their women will seek sexual gratification among those women of the society (the Bajau) where such behavior is permissible.

Such has been the case at Si Tangkay and a few enterprising Bajau women have had considerable financial success in the world's oldest profession. Charging for their sexual favors is not a great break from tradition since it is proper Bajau etiquette for a young man to present gifts or payments to the girl he is attempting to seduce. Some business-minded Bajau women made considerable money from prostitution when young, then retired to respectable marriages as adults. I emphatically add, however, that only a small minority of house-dwelling Bajau women are involved in prostitution: many, in fact, accept the Islamic prohibition against premarital sexual relationships. Probably as the Bajau community becomes more completely acculturated to Islamic values, prostitutes will have low status and premarital sexual relations will become taboo.

Among the more spectacular results of the Bajau move from boats to houses are the large, extended matrilocal households. Whereas the boat-dwelling Bajau lived in single-family houseboats, the Si Tangkay Bajau live in multifamily households—the largest housing seventeen families—related through female kin ties. Reasons for the large households are practical. In the early days of house living, many families continued to make periodic fishing trips. Rather than leave the house empty and unused, a shame-

Uninhabited until the 1900s, Si Tangkay Island was settled by Bajau soon after a Chinese merchant had opened shop there. The Bajau have adopted a number of Moslem characteristics, among them, the standard Filippino style of dress.

ful waste in Bajau eyes, kinsmen lived in the house while the owners were away. Or in some cases, several related families built a house together with the intent of sharing it when resting from fishing trips. As fishing passed increasingly into the hands of the men, and motorboats allowed some of them to fish great distances and still return home at night, a permanent group of people remained in the house.

The matrilocal nature of the household reflects practicality as well as cultural norms. Before moving to houses, the Bajau professed a preference for matrilocality; ideally a couple lived with the wife's family or at their mooring after marriage. However, the demands of fishing cycles and the size of the houseboats frequently made this impossible. With houses the ideal was put into practice. And as Bajau frequently told me, if wives remain at home while their husbands are away, it is best they stay with compatible women, namely their sisters or other kinswomen.

Seemingly related to the large households is another change—the rate of divorce. Divorce among the house-dwelling Si Tangkay Bajau is considerably higher than among the boat-dwelling Bajau. Geneologies of the house-dwelling Bajau reveal that this increase in divorce dates from the move to houses. Some of the change can be attributed to house living per se. In the past, a newly married boat-dwelling couple spent a few weeks with the parents who had space for them, and then set up residence in their own houseboat. If a boat was available, they immediately began living alone. Thus, they were on their own to work out the problems of establishing the new household. However, among the house-dwelling Bajau, the newlyweds live in the house of the bride's family. At marriage, which is arranged by kinsmen, the groom is frequently unacquainted with his bride and her family and feels very much a stranger in the large household. The nature of Bajau kin sentiments usually means that the entire household sides with the bride in the event of any disagreement or quarrel between the newlyweds. Not surprisingly, the groom feels isolated and alien in the new household. Many marriages do not survive these early months, but should the wife becomes pregnant, this will usually cement the union.

The move from boats to houses has even resulted in physical changes in the Bajau. Genetically, the Bajau are little different from the surrounding populations. They are of the so-called Malayan physical type, as are most of the people of insular Southeast Asia. Because of constant exposure to the sun, the skin of the boat-dwelling Bajau is normally darker than that of the land-dwelling people, and their normally black hair is often sun-bleached to shades of red or even blond. But the one characteristic of the boat-dwelling Bajau that sets them apart from their land-dwelling neighbors can be attributed to their unique way of life. The legs of most adult boat-dwelling Bajau are weak and underdeveloped, the result of hours spent squatting, legs jackknifed, while paddling and living in the low houseboats. Many old people are unable to lock their knees when they stand upright; some of the weaker ones cannot even stand upright and spend their final years squatting and sitting in their boats while kinsmen attend to their needs. A deformation of the lower spine, also apparently due to the squatting habit, causes the buttocks of some to protrude abnormally when they stand upright. These physical results of boat living give the Bajau a distinctive gait, and boat dwellers can be identified on this basis alone. On land, their walk appears clumsy and uncertain, but it is well adapted to moving on boats or from boat to boat when at sea. Older house-dwelling Si Tangkay Bajau reveal the physical charactertistics of their earlier years as boat dwellers, but the present generation does not. The legs of the youth are strong and well developed, and their gait and physical appearance are indistinguishable from that of the other peoples of Sulu.

With their incorporation into the mainstream culture of the Sibutu Island Group, the Bajau have acquired a greater role in the political affairs of the islands, which were traditionally controlled by local, land-dwelling district headmen, or datu. The datu owed allegiance and tribute to the Sultan of Sulu who resided in Jolo, the capital of Sulu Province. Dispersed over the Sibutu waters in their small flotillas, the Bajau, were occasionally asked to contribute to the endeavors of the datu, but for the most part they were outside the flow of Sulu politics. As they began to concentrate in Si Tangkay and the political structure of Sulu altered, the role of the Bajau changed. With the coming of elected public officials in 1959, the large Bajau voting block in Si Tangkay became a majority with which aspiring local politicans had to deal. Although the highest public officials are still non-Bajau, they must give concessions to the Bajau to win their seats. Consequently, a Bajau man is on the community council, Bajau men are on the police force. Bajau are invited to participate in community celebrations, and the mayor of Si Tangkay has a Bajau woman among his four wives.

It is difficult to predict what the future holds for the Bajau. One possibility is that their present acculturation to Islam will continue until they become indistinguishable from the other people of Sulu. On the other hand, they could return to their boats and reverse the acculturation process. Should fishing, the mainstay of Bajau life, be exhausted in the Si Tangkay reefs, a real likelihood as the population increases, the Bajau will have to look elsewhere for sustenance. Ultimate survival may depend upon families once again dispersing in small houseboats to try their individual luck. Civil disorder could also drive the Bajau back to their boats. It would be easy for most Bajau to return to boat living. For the adults, it was a way of life until fairly recent years, and for young people it has always been an alternative to house living while fishing or visiting neighboring villages.

For the Bajau have never actually left the sea; they have simply moved from boats upon it to houses above it. Flexible enough to accommodate either life-style, Bajau culture is not yet committed to one over the other. And since flexibility is the key to survival, the Bajau may very well survive future, unknown upheavals. Perhaps the Bajau, able to live on the eternal sea, will survive other peoples who must dwell upon the more ephemeral land. ☐

Today few Bajau follow the seasonal migrations of fish, but fishing, now done close to the settlements, is still their principal livelihood.

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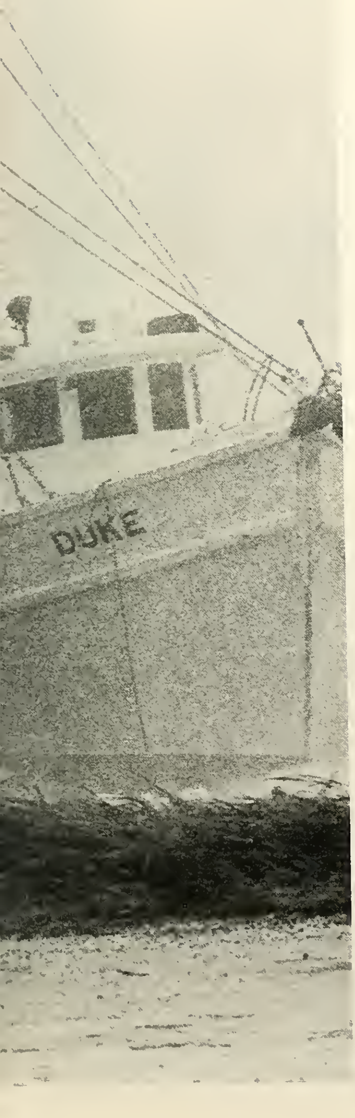


Disaster from the Tropics

The dynamics of hurricanes—from birth to maturity—suggest ways in which the most destructive storms on earth might be modified

by R. Cecil Gentry

"A man on Long Island had satisfied a lifelong ambition by ordering an expensive barometer from Abercrombie & Fitch. It arrived the morning of September 21st. Eagerly, he unwrapped it and was disgusted to find the needle stuck at 'Hurricane.' After shaking it in a vain attempt to start it working right, he sat down, wrote a very stuffy letter to A. & F., and went right out to mail it. When he returned, his house was gone, and the barometer with it."

From *The New Yorker*
November 12, 1938.

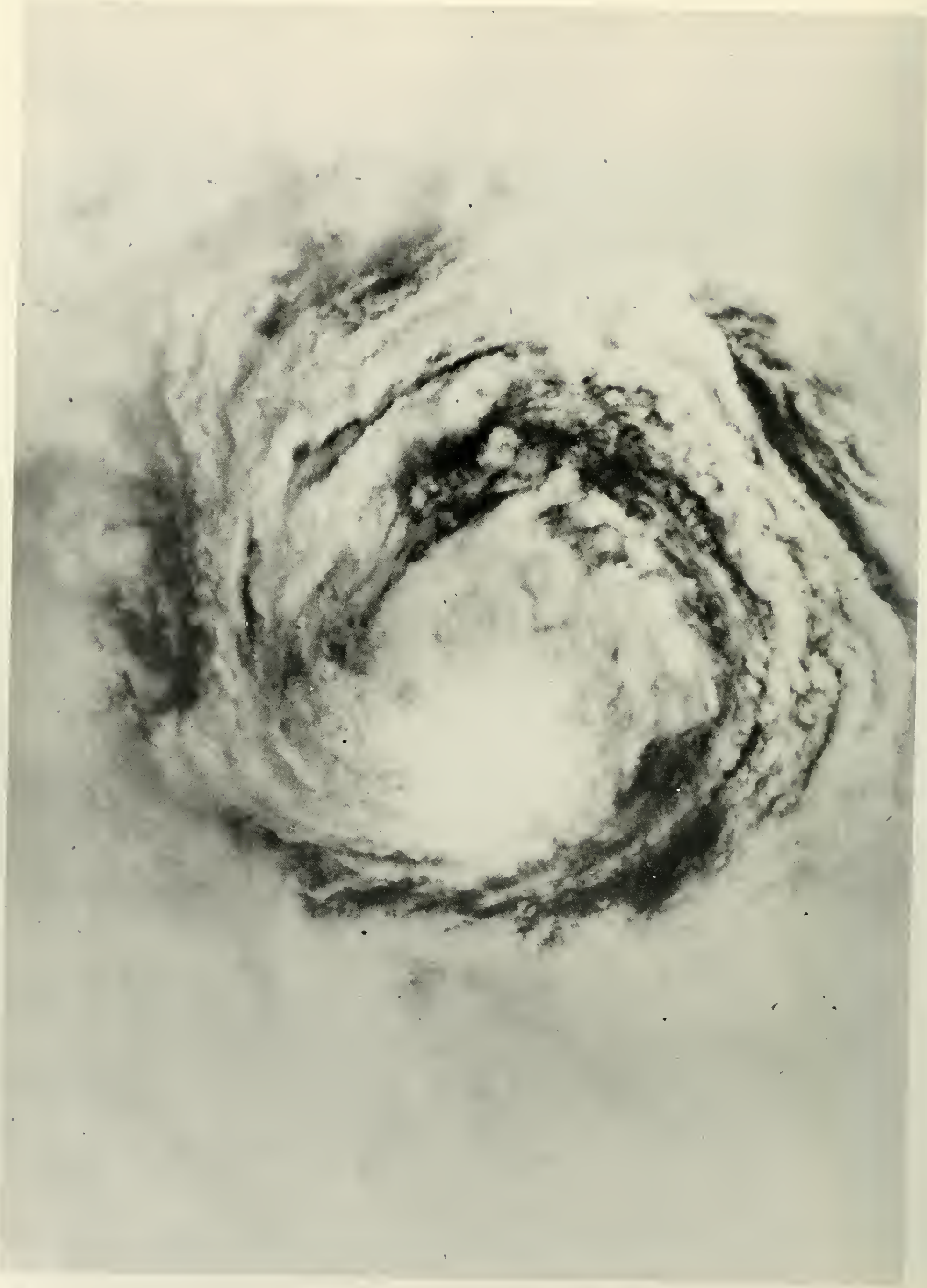
That incident took place as a hurricane with winds of 100 miles an hour roared up the Atlantic coast from Cape Hatteras, North Carolina, to Nantucket Island, Massachusetts—far north of the usual hurricane belt—toppling trees, destroying buildings, sweeping cars off the roads and trains off their tracks, causing thirty-foot waves, and leaving a toll of about 600 dead, 2,000 injured, and half a billion dollars' worth of damage.

One to three hurricanes usually strike the United States annually. Improved detection techniques and warning systems have greatly reduced the number of deaths hurricanes cause, but because of increased coastal development, property loss has risen. Hurricanes Betsy in 1965 and Camille in 1969 created more than $1.4 billion damage each; in 1972 hurricane Agnes was responsible for $3 billion property damage.

Almost all countries lying on the western sides of the oceans, especially those in or near the tropics, have experienced disasters resulting from these violent storms. The devastation outside the United States is often even more catastrophic than in this country. In 1970 three typhoons, as hurricanes are called in the western Pacific, that hit the Philippines within a few weeks made the difference between a growing economy and one struggling merely to survive. That same year a tropical cyclone (still another name for a hurricane used in some parts of the world) swept in from the Bay of Bengal across the low-lying islands of Bangladesh and killed about 300,000 persons, mainly by drowning.

Hurricane damage results from three principal factors: the destructive force of the wind; the storm surge, or rise of the water level along the coast as a hurricane moves inland: and the floods caused by torrential rains, which can average six to twelve inches in a period of 24 hours or less.

Hurricanes, among the most destructive weather phenomena on earth, originate over warm, seem-



NOAA

ingly peaceful tropical waters. By definition, they have winds stronger than 74 miles per hour. Maximum winds, however, vary from storm to storm and have been known to reach velocities of 150 to 200 miles per hour.

Although all the conditions necessary to change a mild tropical disturbance into a full-scale hurricane are not entirely understood, we can draw a portrait of a mature tropical cyclone. A fully developed hurricane may cover an area 300 to 400 miles in diameter and last from one to thirty days. Its most unusual feature is the eye, or storm center: a region of low pressure, relatively calm winds, temperatures 10 to 15 degrees warmer than the surrounding air, little or no precipitation, and only a few clouds. The diameter of a typical eye is about fifteen miles. Around this comparatively peaceful core, towering clouds form a wall in which the storm's heaviest rainfall, maximum winds, and most intense turbulence are located. These eye-wall clouds have bases about 500 feet above the sea's surface and tops that reach 40,000 to 50,000 feet.

The wall clouds are themselves surrounded by a great expanse of active rainbands, lines of clouds with greater than average vertical development and often intense rain, which spiral from the outside inward toward the center of the storm. These rainbands are the principal way a hurricane can be identified on a radarscope or in a satellite picture. They indicate the paths of the winds that carry warm, moist air into the storm's structure. It is the latent heat in this moist air that powers a tropical cyclone.

Meteorologists liken a hurricane to both a giant pump and an enormous heat engine. The storm sucks up large masses of essential moisture-laden air at low levels, swirls it upward, and expels it at great heights. As the incoming warm air rises through the eye-wall and neighboring rainband clouds, it expands and cools, its water vapor condenses into droplets, releasing its latent heat and making available huge amounts of energy. In a mature hurricane, as much as several quadrillion pounds of this air flow into the storm circulation every twenty-four hours; more than 80 percent of the water vapor in the air condenses and eventually falls from the storm as rain. In the condensation process, quintillions of calories of latent heat are released. In a single day a moderately intense hurricane often releases as much heat energy as would be released in the simultaneous detonation of 400 twenty-megaton hydrogen bombs. If converted to electricity, that amount of energy would be sufficient to supply all the electrical needs of the entire United States for more than six months. Furthermore, hurricanes release this energy day after day until they weaken and dissipate—a period that averages a week.

Fortunately, the hurricane, although powerful, is a rather inefficient heat engine; only between 2 and 4 percent of its enormous heat energy is converted into kinetic energy, the energy of motion. But the total heat energy released is so great that even this small percentage is enough to produce the hurricane's fiercely destructive winds.

Forces with the magnitude of those in a hurricane cannot be overcome by direct confrontation. Research into possible man-made hurricane modification has therefore been devoted to finding the hurricane's Achilles's heel, interrupting its complex interrelationships, and learning how to trigger a chain of events that will make the storm work against itself.

Knowledge needed for studies of hurricane modification was not acquired until after regular aircraft reconnaissance of these storms was initiated by United States military services in 1944. Although those early observations were directed primarily toward tracking hurricanes and measuring their maximum intensity, many airborne observations provided details about wind, pressure, and cloud structures. Since 1955, highly instrumented research aircraft have made periodic flights through hurricanes, recording data as often as once per second. In recent years meteorological satellites have also contributed information on hurricanes in the formative and mature stages. In addition, theoretical and numerical models that simulate many features in the life history of tropical cyclones have been developed. By using these models to supplement and interpret the hurricane data that have been collected directly, many of the things that must be known before successful modification experiments can be conducted have become better understood.

In the tropics, winds are normally rather light and pressure and temperature are usually uniform over great distances. In a hurricane, however, the winds are strong and the pressure and temperature change rapidly with distance and altitude. Therefore, the two main questions to be answered are what makes hurricane winds so violent and what accounts for the changes in pressure and temperature? The same set of interlocking relationships explains both these phenomena in a fully developed hurricane, an almost self-perpetuating system.

Air pressure in a hurricane is high at the periphery and low at the center. Just as water runs downhill, air rushes inward from high- to low-pressure areas. The greater the pressure difference, the stronger the winds will be. The converging air rises around the eye in a whirling column of winds. When the moisture in this air condenses, it releases heat energy that warms the air at the core. As the air around the eye ascends, some air within and near the eye descends. Compressional heating as the air flows downward causes additional warming in the eye region. The net result is a pool of warmer air near the core of the storm. This warm pool, extending through much of the depth of the atmosphere, contrasted with the air of normal temperature toward the periphery, causes the

The eye of a hurricane, an area of relative calm, is seen from an Air Force plane monitoring the storm to gather meteorological data.

pressure gradient to be strong, which, in turn, keeps the winds blowing. As long as there is plenty of warm, moist tropical air to flow in toward the center of the storm, and the ocean is warm enough to keep supplying heat and water vapor to this air, the hurricane has the potential of maintaining itself indefinitely. In actuality, many tropical cyclones sustain a high level of intensity for periods of five to twenty days, as long as they stay over warm waters. Over cold water or land. hurricanes decay rapidly.

This chain of events not only explains the mechanisms by which a hurricane maintains its energy levels, but also suggests potential weaknesses that might be exploited in attempting to alter the hurricane artificially. For example, if the warm pool of moist air over a large expanse of ocean could be dispersed or the inflow of that air slowed, it would be possible to reduce the storm's intensity. If the transfer of energy from the ocean to the atmosphere inside the hurricane could be stopped, the storm could be moderated. Or if the pressure and temperature gradients could be reduced by other means, the hurricane could be tempered.

Various suggestions concerning ways to change the temperature field have, in fact, been made. First, since the warm core is primarily produced by the latent heat released in the air columns rising near the eye of the storm, temperature could be affected by reducing the water vapor in those columns. Studies of the structure of hurricanes indicate that part of the vapor condensed in these rising columns is evaporated from the ocean inside the high wind area of the hurricane. This has led to the suggestion that a chemical film be spread over the ocean to reduce evaporation. Theoretical models of hurricanes indicate that stopping evaporation of water from the ocean to the atmosphere inside the hurricane would indeed reduce the intensity of the storm quite dramatically—by more than 50 percent within 24 hours. Unfortunately, there is no known film capable of suppressing evaporation and strong enough to persist in the high waves and furious winds of a hurricane.

Another suggestion involves cooling the ocean water in advance of the hurricane. This could mean bringing cold water up from the ocean depths to mix with warm water at the surface, towing icebergs into hurricane areas, and other equally imaginative, but impractical, approaches. They all depend, among other things, on knowing the exact track of a hurricane several days in advance, information not now available.

Still another suggestion is to drop solid or liquid carbon dioxide in the eye and wall clouds to cool the air in the inner core of the storm. A variation of this is to drop urea in the wall clouds. The urea would combine with the water in the clouds, taking heat from the air and thus reducing the temperature. Calculations indicate that about 100 aircraft would be required to carry enough of either of these compounds to reduce the temperature even one or two degrees centigrade, and many would have to be in the storm's core at the same time. This would obviously be an unsafe operation.

Finally, there are the logistically practical suggestions that offer realistic possibilities for successfully modifying hurricanes. These involve modifying the mechanism by which heat is distributed through the storm. This is the approach adopted in the Project Stormfury experiments carried out jointly by the National Oceanic and Atmospheric Administration and the U.S. Navy and Air Force.

Supercooled water—water that remains liquid even though the temperature is below the freezing point—is found in the clouds at the tops of mature hurricanes. This water provides an opportunity for modifying the heat-release processes and, in turn, the interaction between the clouds and larger scales of air circulation. Water drops in clouds do not automatically freeze when the temperature is below 0°C. A freezing nucleus must be present for the water to turn to ice unless the temperature is as low as −40°C. Ice crystals make excellent freezing nuclei, and there are many other natural substances that serve this purpose. In hurricanes, however, there is often a deficiency in ascending air currents of freezing nuclei that are active at temperatures below the normal freezing range. If freezing nuclei are artificially introduced into the building clouds by the technique known as cloud seeding, the supercooled water droplets will turn into ice. The phase change from liquid water to ice causes a release of the latent heat of fusion.

If this process takes place in a sensitive region of the hurricane, it may cause significant changes in the storm. For example, studies of hurricane structure and, in particular, results from experiments with hurricane models, suggest that heat added in areas outside the radius of maximum ascending motion, the eye wall, can cause reduction in the maximum winds of the hurricane.

A second result of cloud seeding also selectively adds heat to a storm. Experiments have shown that under certain vertical temperature and humidity distributions, seeded clouds will grow more than they would have grown naturally. As they grow, more water is condensed and much greater quantities of latent heat are released. Calculations with theoretical models indicate that this heat of condensation released by augmented cloud growth would be many times greater than the heat of fusion released by freezing of the existing water alone. Furthermore, indications are that a new eye wall can be developed if the growth of clouds can be encouraged in the inflowing air several miles beyond the original eye wall. Inflowing air at sea level could then ascend through the new eye wall to the outflow layer at the top of the storm, and the farther away from the center of the storm the air ascends, the more the wind speeds will be moderated. Thus, developing a new eye wall by seeding clouds radially outward from the old eye wall may provide a mechanism for reducing the maximum winds in a hurricane. The process would also serve to release the latent heat at a greater distance from the center, thus reducing the temperature and pressure gradients.

Experiments to modify hurricanes, which began in 1961, have all used silver iodide crystals dispensed from aircraft as the freezing nuclei. These seeding experiments seek to reduce the maximum winds by dispersing over a larger area the energy that normally is concentrated in a relatively narrow band curving around the center of the storm.

The force of the wind varies with the square of the wind speed. This means a wind of 100 miles per hour exerts four times as much force as a wind of 50 miles per hour. Similarly, a reduction in the maximum wind speed of 10 percent would mean a reduction in the force of about 20 percent.

The area in which hurricane modification experiments can be conducted is quite restricted. The aircraft used in the Stormfury experiments have been based in Puerto Rico and Florida. Since the planes remain in the air for several hours while monitoring a storm, the hurricanes selected must be within 700 miles of an operating base. To lessen the possibility of litigation involving liability should a seeded storm suddenly veer inland, and because proximity to land modifies the properties of hurricanes, those deemed eligible for experimentation must have only a 10 percent probability or less of coming within 50 nautical miles of a populated area within eighteen hours after seeding. In addition, the storm must be fully mature rather than already weakening, and the clouds must contain ample amounts of seedable supercooled water. In view of these qualifications, it has been possible to experiment with seeding on only four hurricanes since the program began twelve years ago. The principal data used in evaluating those experiments were the measured winds and the observations of the size of the eye. The results were encouraging but not conclusive.

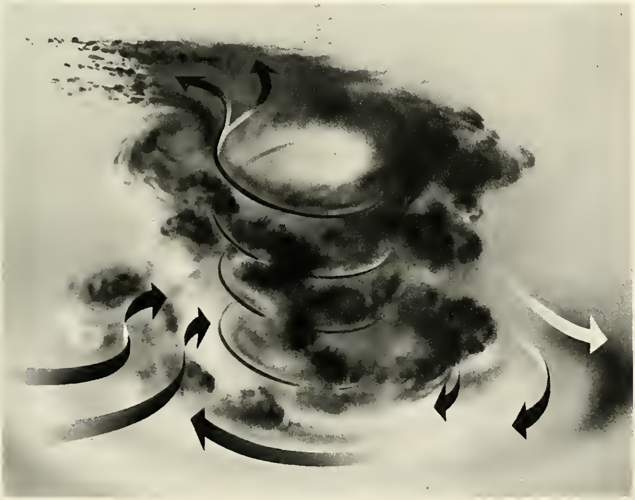
It is relatively simple to drop silver iodide in the clouds. It is not much more difficult to measure how the storm changes with time. But hurricanes are naturally variable. The expected reduction in maximum winds from seeding experiments is about 10 to 15 percent. Many storms have changes of equal magnitude due to natural variations. The real problem is establishing beyond doubt that a reduction of 15 percent was effected by the seeding, independent of natural changes.

One suggestion is to design a randomized experiment in which some storms, selected by chance, are seeded and some are used as controls. Unfortunately, such an experiment requires a large number of storms. Since one of the biggest problems Stormfury has faced to date has been inadequate opportunity for experimentation, the project has sought other means of evaluating the experiment, namely the development of theoretical hurricane models. They have made it possible to calculate the expected effect of seeding and to design a better means of evaluating the experimental results.

In conducting any experiment in artificial weather modification, possible harmful side effects must be considered. Concern has been expressed over possible effects on rainfall, the storm's track, general circulation of the atmosphere, and potential damage to plant and animal life caused by the silver iodide.

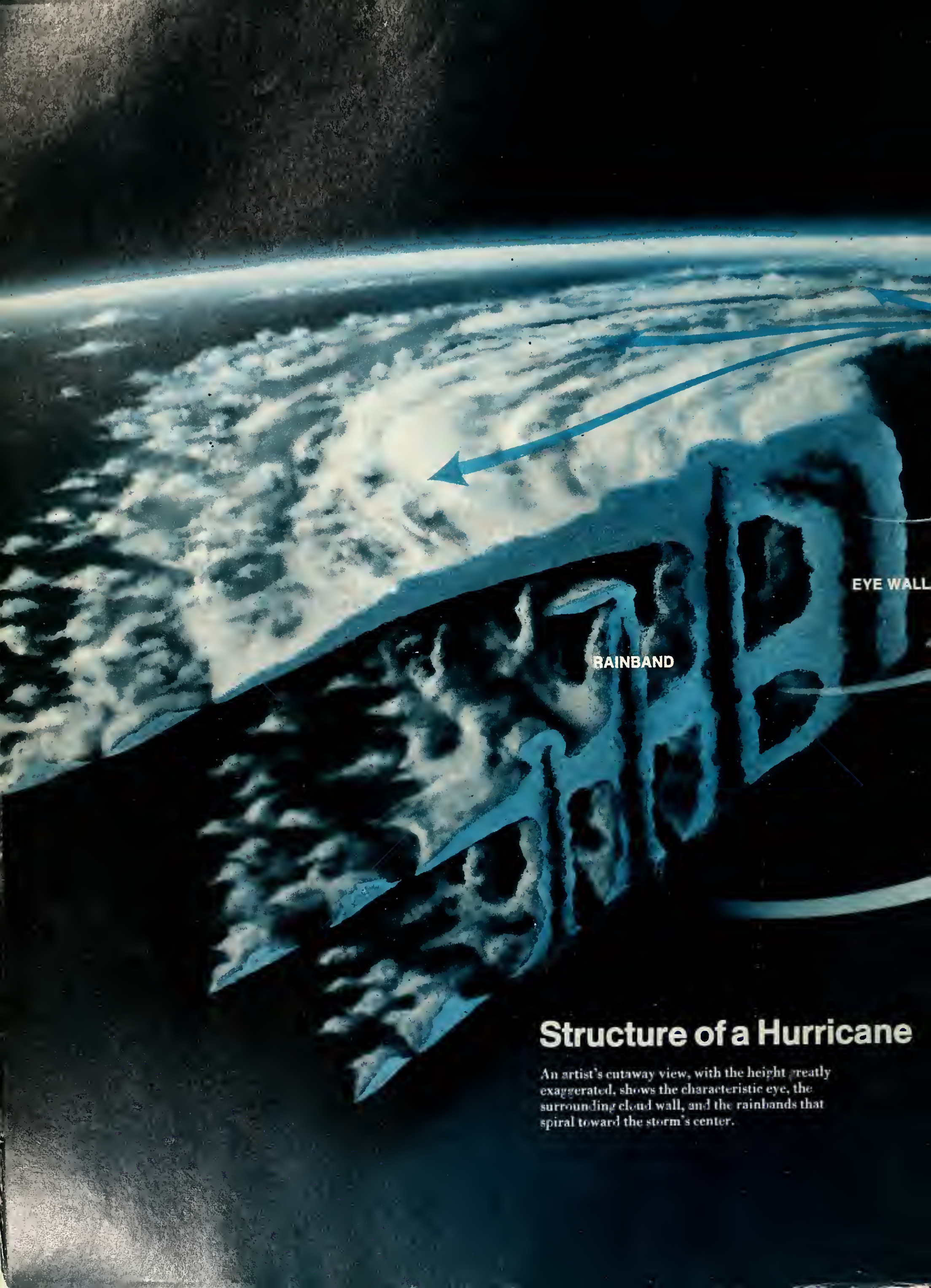
Many areas of the world depend on rainfall from tropical cyclones to alleviate drought, fill reservoirs, and satisfy other water requirements. An often raised question is whether modifying a hurricane will significantly affect rainfall patterns. The data collected in modification experiments to date, although inadequate to answer this question fully, do not indicate that the experiments had any significant effect at all on the rainfall. Theoretical models suggest that seeding will cause a small increase in the total rainfall in the storm, but that the rainfall will also be more widely distributed. If future field experiments confirm these indications, the effects would be beneficial. That is, the semiarid regions of the world would continue to get the needed rain from modified tropical cyclones without an increased probability of floods in other areas.

Those concerned about rainfall also ask if the experiments will change the course of the storm and take the needed rainfall to an entirely different area. All research on predicting hurricane tracks suggests



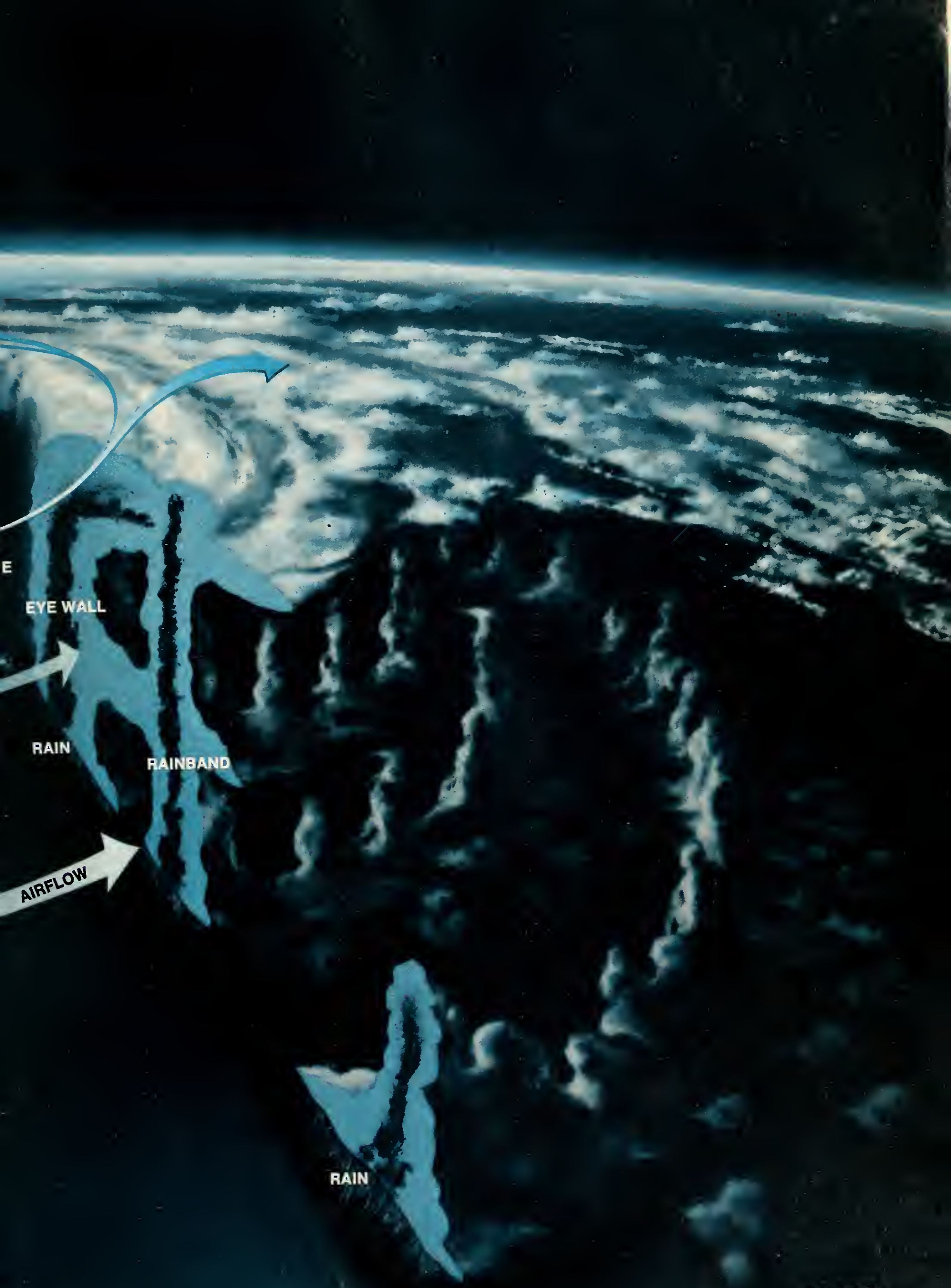
HELMUT WIMMER

The circular motion of the air converging around the storm's eye is due to the rotation of the earth, which deflects winds north of the Equator to the right, those south to the left.



Structure of a Hurricane

An artist's cutaway view, with the height greatly exaggerated, shows the characteristic eye, the surrounding cloud wall, and the rainbands that spiral toward the storm's center.


E
EYE WALL
RAIN
RAINBAND
AIRFLOW
RAIN

HELMUT WIMMER

that the modification would have little, if any, effect on the direction of motion of the storm. This problem can only be studied with a full three-dimensional model of a hurricane that includes interaction with the environment. Work is under way on such a model.

Future hurricane-seeding experiments are not expected to have any noticeable effect on the general circulation of the atmosphere either. To bring about such a result, the experiments would have to destroy the hurricane, change its track, or affect its rainfall. No significant changes are anticipated in any one of these areas.

Finally, evidence accumulated so far has not shown any harmful effect on either animal or plant life caused by the silver iodide used for seeding. In fact, one of the big problems in postseeding analyses is finding any traces of silver iodide in the rain water to analyze.

To homeowners, hurricanes, one of the most awesome of natural phenomena, are potential destroyers; to public officials, they are a threat to the community. To scientists, however, they are a problem that appears to be solvable. Hurricane-seeding experiments, the most promising method yet tried for modifying these storms, have been temporarily suspended for two or three years to provide time for procurement of new aircraft and the installation of improved instrumentation. In the meantime, research continues on the physics of hurricane clouds, the interaction between the ocean and the atmosphere in tropical cyclones, the natural variability of hurricanes, and the development of improved numerical models for computer hurricane experiments. The ultimate goal is to tame these greatest storms on earth. ☐

The usual hurricane season in the United States is from June through November. Areas most often hit are the Gulf states and Florida.

The Turning of the Leaves

When their time comes, leaves die with care, conservation, and glory

by Patricia W. Spencer

photographs by Bob Meyers

In a riot of color, autumn leaves announce the end of summer and the approach of winter. To humans, the dying leaves are a source of beauty, but to the tree, they mean survival.

The foliar display of autumn colors in most northern temperate zones begins in late September or early October and crescendos in November, depending upon the weather and the lack of an early, heavy freeze. The most visible and obvious sign of leaf decay and death, or senescence, is the loss of the green pigment chlorophyll and the emergence of other, warm-colored pigments, such as anthocyanins and carotenoids. Anthocyanin pigments, which predominate in pin oak, scarlet oak, and sweet gum trees, create leaves of red or scarlet. When carotenoid pigments predominate, as in birch, tulip, and poplar trees, leaves turn bright or golden yellow. In the sugar maple, red maple, and chestnut oak trees, both pigments are present in varying degrees, creating shades of orange or a mixture of orange, red, and yellow, all in one leaf. Other trees, such as the apple, white oak, and sycamore, merely lose their chlorophyll and become paler green with touches of brown.

In most tree leaves, the already present pigments are revealed when the overpowering green chlorophyll dwindles. In others, the pigments are produced in the leaf after the chlorophyll has substantially disappeared. The production of crimson anthocyanin, in particular, requires cool autumn temperatures. A cold spell, during which anthocyanins are produced extensively in almost all tree leaves, followed by warmer weather is responsible for the beautiful colors of Indian summer. In the last stages of leaf death, polyphenols, complex organic compounds, contribute a tan or muddy brown appearance to the leaf.

Shortly after a leaf begins to lose its chlorophyll, it also begins to lose the ability to retain water and remain turgid. The membranes surrounding each cell become "leaky" and no longer act as semipermeable barriers to solutes in the cell sap. Cellular fluids ooze out of the cells and flood the intercellular spaces, rendering the leaf translucent, like cooked celery or spinach. This state of affairs does not last long, for the water soon evaporates, leaving the leaf drooping, dry, and shriveled. The now desiccated brown leaf falls from the tree and becomes matted into the ground below.

As autumn rains and winter snows percolate through the fallen, matted leaves, they remove traces of minerals, especially calcium, and return them to the soil, where soil bacteria and fungi feed upon them. The leafy skeletons of cellulose that remain on the surface act as a mulch, holding in soil water and modulating soil temperatures.

By the time the visible signs of senescence appear, the leaf has already undergone a series of events that will lead to its eventual death and the tree's survival. Before it finally falls from the tree, dry and brown, the leaf will have returned more than half of its nitrogen, phosphorus, and potassium to the permanent tissues of the tree, plus some magnesium, sulfur, and manganese. Calcium, which is not easily removed, is the only mineral element remaining to any degree.

Japanese maple

Striped maple, left, and American beech

Red maple, left, and poplar

Japanese maple

Northern red oak

Through the process of translocation, the mineral elements removed from the attached, slowly dying leaf are carried into the permanent woody structures of the tree. The translocation fluid containing these minerals moves downward from the leaves, mainly through the xylem in the wood or interior tissues, where some of it is removed by living cells and stored over the winter. Other parts of the fluid are stored in living bark tissues, while the rest continues on down to the roots for overwintering.

Even evergreens, which remain green and retain their chlorophyll-filled foliage throughout the winter, eventually shed their old leafy growth and undergo a similar reclamation of mineral elements. While most evergreens shed old needles or foliage in the autumn—at the same time that deciduous trees shed their leaves—some do so in other seasons.

This reclamation of mineral elements from dying tree leaves, along with a concurrent removal of carbohydrates, is not merely an illustration of natural conservation; it is a process absolutely essential to future growth.

Many trees, such as cherry and dogwood, flower in the spring long before any leaves appear on the branches. Where do the opening flowers obtain the carbohydrates necessary for growth? The tree has no leaves to produce carbohydrates by photosynthesis. Where do the flowers get the necessary nitrogen? The roots are unable to take up sufficient nitrates from the thawing ground. (Roots do absorb nutrients from the soil in winter, but in very limited quantities.) Even trees that do not flower in the spring must still supply nutrients to the developing leaf buds. In the spring, all the growing points in a tree require tremendous amounts of nitrogen and carbohydrates.

Trees open flowers and develop leaves because of the stored reserves of nitrogen and carbohydrates produced by the previous year's dying leaves. When a tree breaks dormancy in the spring, "the sap rises," as the old expression goes. The sap, or translocation fluid, surges upward, carrying the stored reserves to the leaf and flower buds. In these embryo tissues a complex series of reactions furnish the buds with the energy and proteins necessary for their growth and expansion.

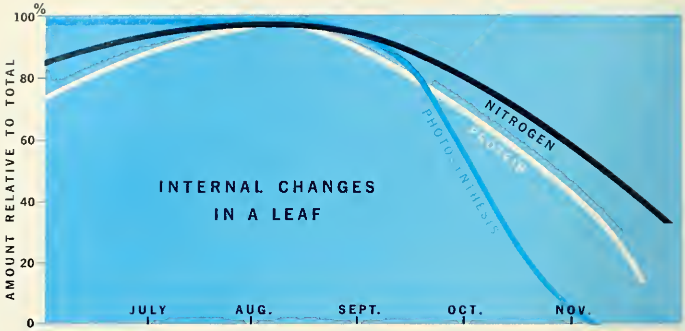
As the leaf bud opens, chlorophyll and the enzymes that are needed for photosynthesis are produced. When the energy of sunlight reaches the expanding leaf, the leaf is ready to produce organic matter literally from air and water. By the process of photosynthesis, the leaf combines, or fixes, the carbon dioxide in the air with water to form glucose. Afterward, other carbohydrates, fats, and amino acids are made, and the yearly cycle of growth and decay begins anew. This newly emerging generation of leaves will, in its turn, senesce and by so doing, provide for the start of the next generation.

If for any reason the removal of nitrogen from a dying leaf is prevented or prematurely halted, the reserves will not be adequately replenished. An early freeze can cause this to happen by inactivating some of the enzymes required to transport nitrogen or by plugging the transport vessels so that no fluids can leave the leaf. This could limit or prevent next spring's budding. Biennial bearing in fruit trees is one result of insufficient nitrogen removal from senescing leaves the previous season.

Until about fifteen years ago, plant scientists reasoned that the loss of nitrogen from a leaf and the transport of that nitrogen to storage in the woody structures of the tree was a natural function of a growing leaf. They did not associate the process with a dying leaf since the loss of nitrogen begins early in the summer, whereas the loss of chlorophyll and the development of autumn colors, processes associated with the dying leaf, do not occur until September at the earliest.

A leaf is a chemical factory and exporter par excellence. Via translocation, it exports the sugars made by photosynthesis to all other parts of the tree. Up to 95 percent of the body of a tree is ultimately derived from the products of photosynthesis formed out of air and water, plus some soil minerals. Obviously, without leaves, there is no tree growth. The export products are essential for all growth as well as for the development of any fruit the tree bears. To mature fully, an apple, for example, requires the imported sugars from as many as 15 to 35 leaves, depending upon the variety of apple. Later in the summer, along with the export of sugars, a leaf also exports amino acids, which contain nitrogen. Thus, it was wrongly assumed that this export of nitrogen was simply a normal function of the growing leaf.

Sometime during the summer—when temperatures are high and tree leaves are deep green with



Before a leaf is visible death, the senescence process starts internally. When day length declines to 14 hours at about the beginning of August, photosynthesis slackens, protein levels drop, and the leaf begins to export its nitrogen to the tree's woody structure.

chlorophyll, when all metabolic processes in the leaf are go—the internal balance between growth and decay tips in favor of decay. Exactly when this occurs depends upon the geographical latitude, the climate, and the tree species. In a sycamore tree in Pennsylvania, for example, the balance tips in late July; in an Illinois apple tree, in early August. The first indication that the balance has tipped (which would pass unnoticed by anyone just looking at a tree leaf) is a decrease in the quantity of protein in the leaf.

In any living, growing cell, whether plant or animal, proteins are continually being synthesized. For a long time it was thought that once a protein was made, it remained stable and active until the whole cell or tissue died. That some, if not all, proteins in a leaf are subject to turnover—synthesis followed by destruction followed by resynthesis—was not discovered until 1962.

All the proteins in every leaf cell are continually being synthesized and then broken down, only to be remade again. As long as more protein is made than is broken down, the quantity of protein in a leaf cell will increase; if the same amount is made as is broken down, the amount of protein will remain constant. But if less protein is made than is broken down, then the quantity of protein will slowly but surely decrease.

The genetic material DNA contains the coded information for the synthesis of each and every protein. Each leaf cell contains thousands, perhaps tens of thousands, of different proteins. The synthesis of each one depends upon the information in DNA. By some as yet unknown mechanism, the information supplied by the DNA abruptly changes when the leaf reaches its maximum size in early summer. The result is that many of the leaf's proteins are no longer synthesized in sufficient quantities to overcome their destruction. Certain proteins continue to be synthesized as before; others are synthesized more than ever; and some proteins are synthesized that were not synthesized before. From this point on the whole metabolic system of the leaf is altered.

One of the proteins with a slowed down or halted synthesis when the balance tips is the main enzyme (all enzymes are protein) responsible for the fixation of carbon dioxide by photosynthesis. After late July or early August, the quantity of this enzyme slowly declines, and its eventual loss is inevitable.

Parallel to the slow loss of the enzyme is the leaf's ability to take carbon dioxide from the air and produce sugars. Other disturbances in the leaf's metabolism are a natural consequence. As less carbohydrate is made, less amino acids can be made, less protein can be synthesized, and less energy is produced. With less energy and less protein, less chlorophyll can be made (this is when leaves start to turn colors), which in turn means less photosynthesis, followed by even less energy, and so on. The end result, of course, is the death of the leaf.

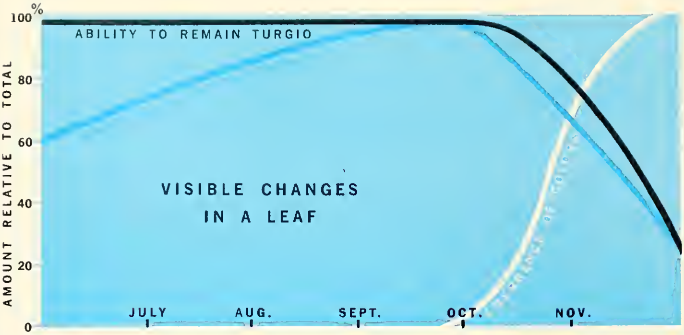
But even as these lethal events are unfolding, the leaf is beginning to export nitrogen and other mineral elements. The removal of nitrogen, however, requires energy, a commodity in short supply in a senescing leaf. Among the proteins that are synthesized in greater quantities at this time are some that, by an ingenious scheme, overcome the handicap of insufficient energy.

Amino acids, the building blocks of protein, are the carriers of exported nitrogen. Most amino acids contain only one atom of nitrogen. When proteins are broken down, however, the released amino acids are not exported directly. Instead, certain enzymes remove the nitrogen from these amino acids to make other amino acids. The nitrogen is not used to make just any amino acid, but rather to make three specific amino acids, which are then exported out of the leaf. The remaining "amino acids," which no longer contain nitrogen and are not really amino acids anymore, are used in respiration for the production of energy. Thus, the dying leaf can have its cake (get energy) and eat it too (remove nitrogen).

The export of nitrogen, the synthesis of these three amino acids, and the synthesis of anthocyanin and other colored pigments are features of dying, not of growing leaves. By September or October, when we can see that the brightly colored leaves are dying, the tree has already reclaimed up to 50 percent of the nitrogen that the leaves once possessed. But this removal of nitrogen and loss of protein, far from being the cause of leaf death, is only a consequence of the initiation of senescence.

No one cause has been found that triggers the commencement of leaf decay or that tips the balance in early summer. Three elements are involved: genetics, plant hor-

The most obvious sign of leaf death—the emergence of bright colors—usually begins in October, when the overpowering green chlorophyll dwindles. At the same time, the leaf gradually loses its ability to retain water and will soon fall from the tree, dry and shriveled.



mones, and environmental influences.

Genetics, or the information contained in the leaf's DNA, is an essential part of senescence. If a certain tree leaf is not coded for seasonal senescence, as in the case of rhododendrons or the younger foliage of evergreens, then that leaf will not senesce, regardless of the other factors. But genetics only propels the events of senescence once they are triggered.

Another factor is a group of organic substances called plant hormones. Three of these—auxin, kinin, and gibberellin—promote growth and retard senescence. Another plant hormone, abscisic acid, retards, or stunts, growth and hastens senescence. These hormones have specific and profound effects upon the ability of DNA to produce its genetic messages and upon the ability of a leaf cell to manufacture protein.

In the early stages of a growing leaf only the first three growth-promoting hormones are produced, but then the third factor of senescence—environmental influence—emerges. As the day length wanes after the summer solstice in June, the leaf produces less and less of the first three hormones but more and more abscisic acid. When the growth-promoting hormones can no longer overcome the effect of the growth-retarding one, the balance between leaf growth and death tips in favor of death, and senescence begins.

The decline in day length plays an important role in other features of plant growth. Photosynthesis requires the energy of sunlight and does not occur at night; this is generally true for protein synthesis as well. For some unexplained reason, the decline in day length that occurs by late July or early August is sufficient to tip the balance. For an Illinois apple tree, for example, the decline in day length from the longest day of about 15 hours to a day of about 14 hours is sufficient. Other tree species respond to a decline of only one-half hour.

The importance of day length in initiating the changes that tip the balance can be seen in "deciduous" trees in the south. Trees that normally shed their foliage annually in the north may retain their foliage all year long in Florida. The southernmost states do not have drastic changes in day length. In Miami, for example, day length oscillates at about twelve hours, plus or minus thirty minutes, all year long. The less variable day length represses any genetic information that would otherwise lead to leaf senescence. In addition, the growth-retarding hormone is not produced to any extent in trees grown in the south; declining day lengths are necessary for its production.

Temperature and weather play small roles in the unseen events of senescence, but are important in autumn coloring and account for the yearly variation in foliar display. As mentioned earlier, cool temperatures are necessary for the full development of crimson pigmentation. Heavy rains can leach the pigments, which are water soluble, from the leaves before the colors are revealed.

In summary, in northern temperate zones, the shortening day length causes changes in the production of the two types of hormones, which in turn cause changes in the information supplied by DNA. These changes lead, in turn, to altered protein synthesis, gradual loss of leaf protein, the export of leaf nitrogen and other mineral elements, and a reduction in leaf chlorophyll, which reveals other pigments. This eventually leads to the death of the leaf, which leads to the buildup of nutrient reserves for next year's buds. Then the cycle begins again.

In addition to returning mineral elements, senescing tree leaves provide one other benefit for the tree as a whole. When abscisic acid concentrations increase in the dying leaf, some abscisic acid is translocated, along with the mineral elements, out of the leaf to the woody tissues. In these tissues, it promotes winter hardiness, enabling the tree to withstand much lower temperatures than would otherwise be possible. Without this hormone exported from the dying leaves, a tree would be far more susceptible to damage by early freezes.

For these reasons, leaf decay and death in the autumn is not a wasteful, useless consequence of a tree's adaptation to northern climates. Rather, it is a functional and essential part of the annual cycle of growth and development of any tree in climates where subzero temperatures would kill the soft, broad-bladed leaf tissues and where the frozen ground would fail to allow for the uptake of sufficient nutrients and water to keep the leaves growing and turgid. Wrapped in its bark insulation, a tree can await the coming of spring when, thanks to the return of the mineral elements and carbohydrates from last year's leaves, it will again produce another crop of "chemical factories." ☐

The Day the Mountain Fell

Time stopped for 70,000 residents of Peru's picturesque Callejón de Huaylas at 3:23 P.M. *on May 31, 1970*

by Daniel and Jean Shepard

photographs by Fred Ward
BLACK STAR

It has been called the Switzerland of South America, but the Callejón de Huaylas needs no picture postcard evocations of middle Europe to do it justice. It is a natural wonder in its own right, a spectacularly beautiful valley carved deep in a double spur of the Cordillera Occidental, the continental divide of the Peruvian Andes.

The western wall of the valley, known as the Cordillera Negra for its black volcanic rock, rises out of the coastal plain less than 30 miles from the Pacific Ocean. It parallels the shore for 110 miles, a forbidding escarpment whose ridge line rises to 14,764 feet.

To the east, the valley is bounded by the more than 100-mile-long Cordillera Blanca, which, unlike its bare and gloomy companion range, is broken by a succession of jagged peaks high enough to be perpetually capped by the gleaming ice and snow that give it its name. Centered in the Cordillera Blanca, and dominating the whole of the Callejón de Huaylas, is Mount Huascarán.

Mount Huascarán's elevation of 22,205 feet is the highest in Peru, dwarfing Europe's Mont Blanc and the Matterhorn by more than a vertical mile. In all of South America, only the extinct volcano Aconcagua, on the Chile–Argentina border, is higher.

The densely populated valley averages only 25 miles in width. Because of its rich soil, plentiful water, and favorable climate, the region produces a variety of crops—tropical in the lower reaches and temperate in the upper—and prize cattle and fat sheep graze the slopes. The rich agricultural heritage predates the Inca Empire; and it was here that the Spaniards discovered the potato, which had been bred by the Indians of Peru from the bitter tubers that were native to the continent.

Flowing through a deep canyon in the lush floor of the valley, the Rio Santa, the largest of Peru's coastal rivers, threads a northerly course. Intermittently the river widens into a series of basins, each of which became the setting for a town, strung one after the other along the banks like ornamental beads on a silver filament.

At the southern head of the valley is the town of Recuay, followed by the provincial capital, Huarás, then Anta, Carhuás, Yungay, Carás, Huaylas, from which the Callejón takes its name, and farthest downstream, Huallanca. Bearing out the promise of the colorful names was an endless variety of architectural fantasy and invention: brightly tiled roofs set off by bone white balconies almost touching across narrow pavements, doorways painted in pastel shades of turquoise blue on one side of the street and umber or green on the other, gaily colored walls of brick or adobe decorated with bas-reliefs and other forms of Peruvian folk art.

Throughout the Callejón de Huaylas, whether in the towns or the countryside, there was always

A number of towns in Peru's Rio Santa valley were devastated when adobe buildings collapsed under the impact of the earthquake.

From the book Earthwatch: Notes on a Restless Planet. *Copyright © by Daniel and Jean Shepard. To be published by Doubleday & Company, Inc.*

the natural beauty of the landscape or examples of native handiwork to attract the eye. It was difficult to conceive of a more unlikely site for a great catastrophe. Yet the valley became just that in the backlash of one of the most destructive earthquakes in the history of the Western Hemisphere.

Peru is part of the earthquake belt that rims the land masses bordering on the Pacific Ocean in an arc extending from the tip of Chile northward to Alaska and then south through the islands of Japan. The South American segment of this arc, 4,000 miles long, is frequently shaken by earth tremors and endowed with active volcanoes, oceanic trenches, and young, still-rising mountain chains. Scientists believe that these manifestations of "geologic immaturity" result from a progressive underthrusting of the Pacific Ocean beneath the continental shelf.

Although numerous large earthquakes have been recorded over the past century in the Peruvian sector, the Rio Santa valley was relatively untouched. Residents of the valley could not recall an earthquake of major proportions in their area for at least three generations.

The potential for death and destruction was certainly there, however. The Callejón de Huaylas must have suffered its tragic share in the earthquake of February 4, 1797, which killed as many as 40,000 people between Cuzco in the south and Quito, Ecuador, more than a thousand miles to the north, and in the quakes of August 13–15, 1868, which killed another 25,000 in Peru and Ecuador. But the valley was unscathed by lesser quakes that took place between 1940 and 1966.

Nearly all of the buildings in Yungay were buried by the avalanche. Struck by an edge of the moving mass, this home was demolished.

Located principally south of the Callejón, in the Lima and Arequipa areas, these exacted scattered tolls of dead and injured.

Although relatively immune from earthquakes in recent times, the valley paid for its physical charms in another coin—the avalanche. Mud slides, rock showers, and every conceivable kind of material cascading from the mountainsides that hemmed it have plagued the Callejón since the dawn of its recorded history. The chief villain is the Cordillera Blanca, whose upper slopes are so steep that grades of 45° to 90° are the rule rather than the exception. In some areas, small icefalls take place several times a day; in others, major avalanches are reported every few months or years.

Such avalanches have wiped out entire communities. The unfortunate village of Ranrahinca, which adjoined the city of Yungay, was annihilated in the early evening of January 10, 1962, when an estimated three million tons of Huascarán's northern peak tore away from the face of the mountain. The huge mass bounced five times in the Rio Santa gorge and then, slowing down to 60 miles per hour crushed all but one of Ranrahinca's houses and buried 3,500 villagers. The rain of boulders traveled nine miles in seven minutes, dropping 13,000 feet.

The survivors of the rockfall, and of the typhus epidemic that followed, rebuilt Ranrahinca, building houses of adobe tile or cement to replace the earlier structures of cane. A visitor to the village observed that the new buildings looked solid but puny against the mountain. It was a prophetic remark.

On May 31, 1970, there was a violent awakening for a 5,000-square-mile area of Peru. At 3:23 P.M., eastern standard time, a shock with the magnitude of 7.9 on the Richter scale took place fifteen miles west of the port city of Chimbote. Throughout the following week, there were at least thirty-seven aftershocks, distributed over an ocean area extending about 85 miles parallel to the coast and 40 miles out to sea.

It is believed that the motion originated in deep faults under the seabed because there were no tsunamis, or seismic sea waves, as might have occurred if the ocean floor itself were wrenched and deformed. Nor was there any movement of known surface faults in the region or warping along the coast.

Reports disagree slightly as to whether the maximum intensity of the shocks inland, especially in the Callejón de Huaylas, was somewhat more or less than 7.9, but the question is academic. Within roughly a hundred-mile radius of Chimbote, unimaginable disaster struck the coastal and mountain regions with the capriciousness that characterizes nature on a rampage.

Most accounts described the tremors as having a pronounced side-to-side motion that, while not strong enough to throw people to the ground, made it difficult or impossible to walk or run. But if humans could stand against the shocks, the adobe structures with which the area abounded could not, and it took fifteen seconds at most before they began to collapse.

There is an uncanny parallel between this earthquake and the one that ruined Lisbon on November 1, 1755. The Lisbon quake also had its origin in the seabed west of the city, and the three great shocks that demolished most of the houses in the lower part of the town killed 50,000 people in a few minutes. Because it was All Saints' Day and the churches were filled with worshippers, the number of victims was higher than it might have been.

Peru's earthquake took place on a Sunday afternoon, hours after church services had ended, but this was no ordinary Sunday. Thousands of devout Peruvian sports fans were indoors, listening to the broadcast from Mexico City of the world soccer matches between the Soviet Union and Mexico. The outcome was important, since Peru was in the finals. Only the fact that the quake began forty minutes before the traditional 4:00 P.M. Sunday film matinees saved many more from being trapped en masse in the theaters.

In the coastal region, with its population of 200,000, a "mere" 1,000 died. It was a different story inland, where time finally ran out for the Callejón de Huaylas. The clock in the cathedral church of Huarás stopped at 3:27 P.M., and doomsday began.

The clock of the Capilla Santa Anna church in Guamadal stopped at 3:27, soon after the first tremors hit the area between Lima and Chimbote.

In the older part of Huarás, the red-tiled roofs of the two- and three-story buildings came down on their occupants, and the walls of adobe brick fell on those who fled down the narrow streets. In 45 seconds, nine-tenths of the buildings had been destroyed, and there were 800 known dead. An area of 100 square blocks was turned into a mass of rubble and broken walls as much as ten feet deep, and 16,000 people, out of a population of 65,000, lay buried in the ruins.

Buildings of brick, with reinforced concrete walls, withstood the shocks with only slight damage. But even this type of construction did not avail where there were inadequate shear walls. One such building, a four-story schoolhouse, collapsed as the pupils were performing a play, and the bodies of two small girls were found beneath that of the priest who had vainly attempted to shield them.

What happened in Huarás was being repeated in dozens of communities throughout the Callejón de Huaylas and at hundreds of remote spots on the slopes of the mountain ranges that hemmed it in. Mancas, situated on the western heights of the Cordillera Blanca above the Rio Santa was typical. Roughly 70 percent of its adobe buildings were destroyed and 3,100 of its 5,000 inhabitants killed. In less than a minute, the Peru earthquake had secured for itself a prominent place on the list of the world's natural holocausts.

It was unimaginable that anything could overshadow the devastation that had already taken place, but the unimaginable happened. A slab of ice and rock a half mile wide broke off the western face of Huascarán's northern peak and began to descend toward the Rio Santa, 18,000 feet below.

The original mass that broke loose is estimated at more than 35 million cubic feet. Moving at incredible speed down the 70° slope of Mount Huascarán, it began to generate awesome properties in response to the natural laws invoked by its huge size and velocity. In its slide, the avalanche took on the character of a highly liquid mudflow: part of the ice melted through friction, and water-saturated sediments were picked up on its downward route.

Accompanied by a deafening noise and preceded by a strong turbulence, the fluid mass is thought to have created its own cushion by entrapping and compressing air beneath it. In this way it was able to override obstructions that might have slowed or stopped it; even ridges of loose morainal material were later found to be undisturbed in its wake.

Hurling three-ton boulders half a mile, wreaking havoc on people, livestock, vegetation, and buildings in the Llanganuco Valley, the avalanche provided a foretaste of what was in store for Yungay and Ranrahinca directly below.

The Llanganuco Valley is cut transversely into the western flank of Mount Huascarán, intersecting the Rio Santa at almost right angles. Now the valley acted as a chute for the immense mass. Traveling at speeds of from 135 to 270 miles per hour as its pathway dipped and eased, the avalanche covered the nine miles to the edge of the river in less than four minutes. At the 8,500-foot level, it separated into three tongues, or lobes, encompassing about six square miles. One lobe buried Ranrahinca and all but 50 of its 1,800 residents; another obliterated several smaller communities; and the third continued toward Yungay, where a ridge, 300 to 600 feet high, stood between the city and the mouth of the Llanganuco Valley. In the past it had acted as protection against landslides, but not this time. Before the eyes of the few horrified onlookers who lived to tell what they saw, a wall of debris as high as a ten-story building reared up over the

Continued on page 80

A statue of Christ remains erect in the Yungay cemetery. It commemorates the death of 3,500 people by an avalanche in 1962.

Show

RICHARD D. ESTES

down in Ngorongoro Crater

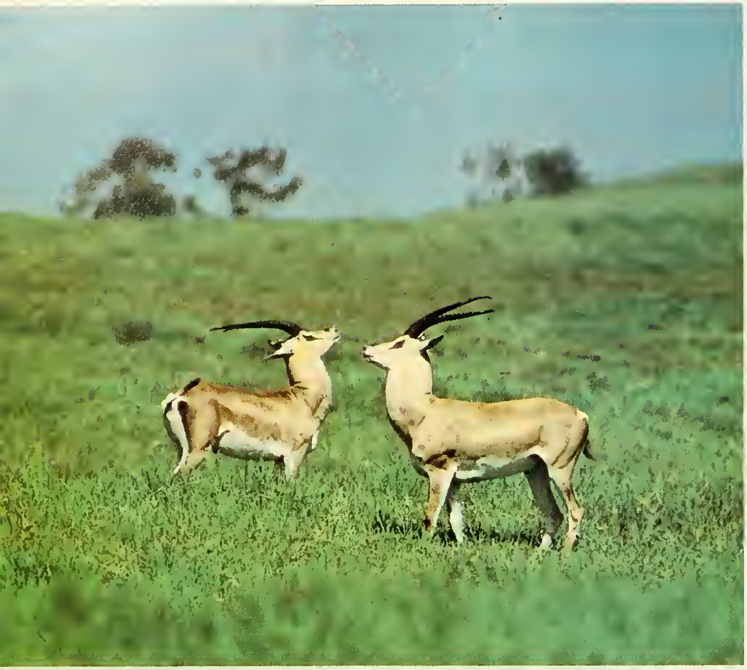
When ritual displays
are bypassed,
two gazelles risk death
until a scientist
turns referee

by Richard D. Estes

With mouths agape and tongues protruding, the two bucks drew deep, rasping breaths. Their forequarters were smeared with blood, most of which issued from their mouths. As the fight continued, they leaned against each other frequently, with horns locked and heads flat on the ground, as though too exhausted to go on. Then one would recover sufficiently to make another thrust, and the struggle was renewed. Neither would yield.

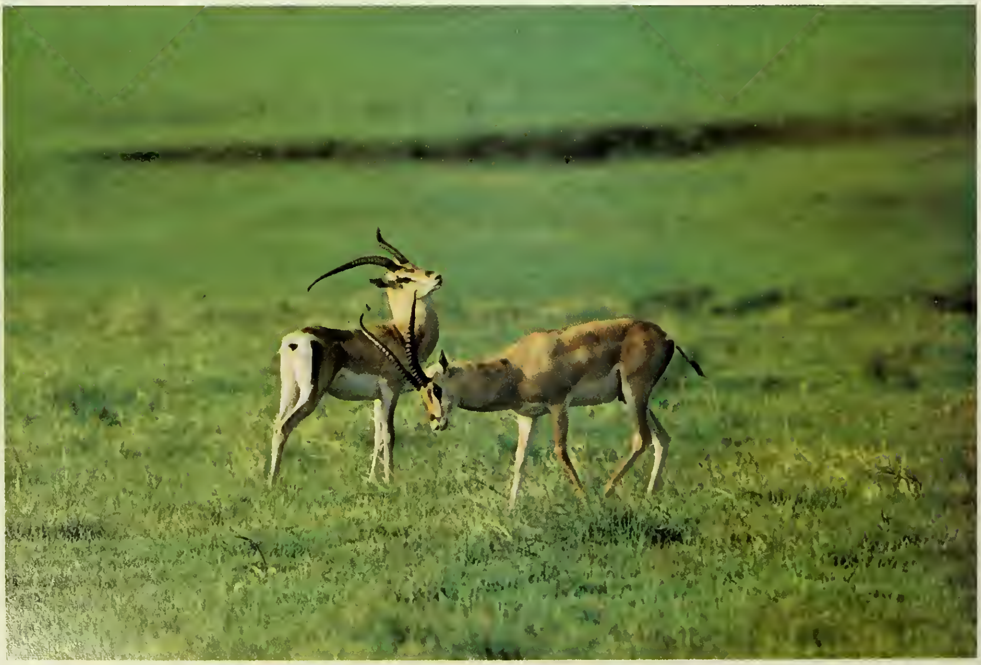
During two and a half years' residence inside Ngorongoro Crater, Tanzania, I had never seen a fight between Grant's gazelle (*Gazella granti*) that led to any apparent injury. Then on a two-month return visit, I witnessed and photographed what I am sure would have been a fight to the death had I not intervened—an interference that I have since regretted. That such a battle royal should have involved the comparatively staid Grant's gazelle made it all the more unusual. To appreciate the novelty of the event, it is necessary to understand the social organization of this species and the normally highly ritualized form of aggression between adult males.

The Grant's gazelle, reaching a weight of 180 pounds and a height of about three feet at the shoulder, is only medium sized, yet so beautifully proportioned that it is one of



RICHARD D. ESTES

Most encounters between Grant's gazelle are settled peacefully through display rituals. With necks upraised and muscles tensed, two bucks, left, circle in a parallel position. A display will end when one buck, below, lowers its head, signifying intimidation.



the most imposing of the seventy-odd African antelopes. Like the sable, greater kudu, and certain races of the impala, male Grant's gazelle have large horns in proportion to their stature. These are strongly ridged, flattened from side to side, and up to two and a half feet long.

Equally impressive are the Grant's movements and carriage. Walking at a deliberate pace, with head held high on its arching, muscular neck, the animal appears serene and stately. By comparison, the much smaller and "busier" Thomson's gazelle (males weigh no more than 60 pounds), which is frequently found associated with its relative, looks like a windup toy.

The Grant's coat, although pale, has the muted beauty of a dove's plumage, the fawn ground color delineated by extensive areas of white and accented by dark lines. Curiously, the bold, dark side stripe typical of many gazelles is entirely lacking in adult male Grant's gazelle. In females, it varies from pronounced to nonexistent but is most often incomplete. One unusual mark of this species, a dark area above the orbit, makes the eye appear large. Such a doe-eyed creature hardly looks fierce.

Compared with the Thomson's gazelle, one of the most abundant East African plains antelopes, the Grant's gazelle is uncommon. In the Serengeti ecological unit there are an estimated 600,000 Thomson's and perhaps one-tenth that number of Grant's gazelle. The latter, however, has a greater ecological tolerance and is found in the more arid parts of northeastern Africa from central Tanzania to Ethiopia and Somalia. It is at home on short-grass plains such as the eastern Serengeti, in acacia savanna, in dense thornbush avoided by most plains game, and even in subdesert. It is primarily a water-independent browser, while Thomson's gazelle is a water-dependent grazer. Both species are migratory if seasonal movements are adaptive to environmental conditions.

Approximately 1,500 Grant's gazelle inhabit the 104-square-mile floor of Ngorongoro Crater, apparently a high density for this species. Here, Thomson's gazelle outnumbers it by only two to one, and since Grant's gazelle weighs two or three times as much as its cousin, it actually achieves a greater biomass. The reason is that there is far more of the tall, slope and hill grassland preferred by Grant's gazelle than of the short, alkaline grassland favored by Thomson's gazelle.

Like the great majority of antelopes, the Grant's gazelle is territorial. Adult males (usually over four years old) maintain individual properties within which the owner is dominant over all conspecifics. Normally, the entire inhabited range is partitioned into a mosaic of occupied territories. Since the boundaries are rarely visible—although known to the owners—the mosaic is more real than apparent. Where the pattern is unobscured by other gazelles, what one sees is a network of mature males spaced out at more or less regular intervals. The territorial grid is permanently maintained in Ngorongoro, so that no matter where other Grant's gazelle go, they are always on some male's property and to some degree subject to his control.

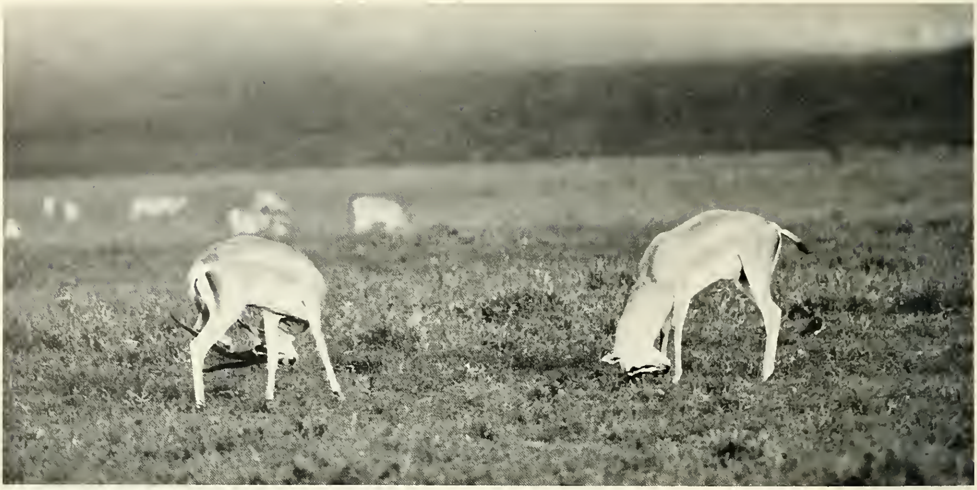
While territorial males seem more attached to property than to their own kind, other Grant's gazelle are gregarious and live together in groups of two types: nursery or harem herds of females and young and bachelor herds of juvenile and young adult males. In Ngorongoro, nursery herds average about sixteen head and bachelor herds about ten head. Herds of fifty head are not uncommon, while aggregated nursery and bachelor herds of as many as one hundred animals sometimes occur. Other than territorial males, the only gazelles that are seen alone are mothers guarding their concealed newborn fawns.

Depending on terrain, vegetation, the season, and population density, territory size can vary greatly. There seems, however, to be a minimum intermale spacing for each species, infringement of which leads to strife and instability. Grant's gazelle maintain relatively large territories, about one-third to one-half square mile in Ngorongoro. Thomson's gazelle tolerate one another within 200 to 300 yards, while wildebeest maintain an average interval of only 150 yards. In large aggregations, territorial wildebeest bulls may tolerate neighbors as close as 30 yards, which is near the minimum known in any antelope of open habitats. Since a wildebeest is three times the weight of a Grant's gazelle, territorial area bears no obvious relation to the animal's size. Territory size does seem to be correlated with the preferred diet of the animal and productivity of the habitat.

There is also an apparent relationship between the size of property and the energy expended on such territorial activities as advertising, herding, and ritualized or actual fighting. In general, species and individuals with small holdings tend to be more actively territorial than those with large holdings. It stands to reason that it is harder to keep potential rivals at a distance and to prevent females from leaving when the area is small. And the more females in a herd, the harder it becomes to control them. In a small territory, however, it is easier to detect and intercept trespassers. With a shorter boundary to patrol and scent mark, the owner can also post it more efficiently. Moreover, he need only stand or lie in the center of his property to manifest his presence to all his neighbors.

Wildebeest and Thomson's gazelle advertise their properties diligently, perhaps partly because their holdings are small enough to be manageable. In addition, the continuing proximity of neighboring rivals may keep them stirred up, for they also put more effort into other territorial activities than do Grant's gazelle. Thomson's gazelle seem to be constantly shepherding and pursuing females and having border skirmishes with neighboring bucks.

Wildebeest chase so actively that herds bound for any distant objective must run a veritable gauntlet of intercepting bulls. They spend nearly all the time not devoted to eating and ruminating on territorial maintenance, including at least an hour a day in ritualized contests with up to six neighbors. These encounters amount to a daily test of



RICHARD D. ESTES

Between displays, gazelles engage in such displacement activities as scratching, left. Buck, right, is probably threatening its opponent by horning the grass.

each male's self-confidence and ability to hold his place in the territorial network.

To win the right to reproduce, such a test of fitness must be met by the males of nearly all territorial species. As a rule, only males with the physical capability and motivation to hold a territory have sufficient aggressive and sexual drive to compete successfully for mating opportunities.

To indulge in a fanciful and anthropomorphic comparison, I would characterize territorial Thomson's gazelle as fussy and hot-tempered, wildebeest as blustering, and Grant's gazelle as dandified. Although I have not made quantitative studies of gazelle behavior, it seems clear that Grant's bucks patrol and mark their property, herd and chase, and duel with their neighbors much less than their two associates. Lacking the waxy secretion that Thomson's bucks are continually daubing on every suitable grass stem and twig, Grant's bucks are limited to urinating and defecating in sequence on the same spot (preferably bare ground), a visual and olfactory territorial display that is probably common to all gazelles.

Another visual display is horning, in which Grant's bucks may rhythmically swing their heads back and forth in a bush or patch of high grass for many minutes. They also spend much time in static-optic advertising—lying out in the open, usually on a slope where they can see and be seen to best advantage.

Unless they approach the territorial boundary, females are seldom energetically herded and chased; most of the time the male moves sedately among them, checking their reproductive status by sniffing their urine and engaging in stately courtship displays. Even when a female is in heat, there is little of the spirited chasing typical of Thomson's gazelle. The greater autonomy and localization of Grant's nursery herds may explain it. Recognizable females can be found in the same locale for months, if not years, on end. Individual territories may thus be large enough to encompass nearly the whole home range, thereby giving a single male virtually an exclusive harem. Of course, this relieves him of much onerous chasing and the need to remain eternally vigilant.

Perhaps most remarkable as an example of the territorial Grant's laissez-faire approach is the extent to which bachelor males are allowed the run of the place. Male herds are not only tolerated within the territory, but they sometimes also mingle with nursery herds and may follow and display to females without provoking any violent reaction from the overlord—as long as he remains the undisputed master.

Such tolerance, however, is not necessarily the rule in this species. In a more detailed study of Grant's gazelle behavior conducted in Serengeti National Park, Fritz Walther found different patterns of territorial behavior in different types of habitat. On the open plains, bachelor and nursery herds typically remain aggregated in mixed herds, which circulate within sizable home ranges encompassing several territories. Each territorial male controls the herd while it is on his ground; when it leaves he either remains behind or joins up himself, in which case he behaves with the meekness of a bachelor male while in a neighbor's territory. In wooded savanna habitat, males defend more clearly defined territories—often a limited stretch of grassland surrounded by bush. Herds are smaller, more stable and restricted. Here bachelor males are not allowed to trespass.

RICHARD D. ESTES

Possibly settling old scores, two bucks meet in all-out combat—locking horns and trying to throw each other—without any preliminary displays.

The grouping patterns and behavior of Grant's gazelle in Ngorongoro Crater appear to be somewhat intermediate to the two patterns just described. While territorial males occasionally allow bachelor males to mix with female herds, the fact that the sexes usually live in segregated groups, intermingling only sporadically, is evidence of a prevailing intolerance.

One category of male that cannot enter a Crater territory unchallenged is the proprietor of a neighboring territory. Adjacent bucks seemingly recognize each other and react from afar if one approaches. I have often seen a defending buck begin trotting to meet a neighbor that was more than one-quarter of a mile away, probably before it crossed their common boundary.

What happens when two neighbors meet depends on a number of variables: whether the meeting is on the border or well inside one of the territories; the presence of a harem and of females in estrus and where these animals are at the time; the physiological state and motivation of the antagonists; and, no doubt, the past history of their relationship. Nonetheless, through a spectacular ritual that may be peculiar to Grant's gazelle, the great majority of such encounters are settled without recourse to combat. I call it the neck display ritual.

As two bucks approach one another, they usually slacken their pace to a deliberate walk and bear themselves proudly. Instead of meeting head on, they move past one another on a parallel course and come to a standstill, side-on or rear-to, five to ten yards apart. With necks upraised and chins pulled in like marines at attention, one or both abruptly turn their heads toward each other and away again—a brief "eyes right!" "eyes left!" With all the neck muscles tensed, the neck looks larger than normal, and as the animals swing their heads from side to side, the muscles play and bulge even more. Thus, the display emphasizes the degree of neck development. The neck is much thicker in males than in females and, together with the size and shape of the horns, distinguishes mature from subadult or even young adult bucks. I believe that Grant's males may evaluate potential opponents primarily on the basis of neck development, secondarily on horn development, and that they will avoid challenging individuals that have perceptibly larger necks.

Through experience gained in the bachelor herds, where the members engage in almost daily tournaments, males have ample opportunity to learn to judge their strength relative to that of their contemporaries. They join these herds as yearlings, after territorial males evict them from nursery herds. The adult bucks harass the juveniles until they no longer try to rejoin the females and younger fawns.

Aggressive behavior, including spirited fighting, is seen much more often between subadult and young adult members of bachelor herds than between mature males. Significantly, the contestants are almost always closely matched by size and age. The reason can be seen on the rare occasions when a juvenile male or adult female spars with a subadult buck: as soon as the two lock horns, the larger twists the smaller's neck and may almost push the animal off its feet. Usually, bucks are so well matched that neither can gain such an advantage. It seems that pushing the opponent out of line and rushing it off its feet by neck twisting is basic to the fighting technique of this species. The risks of injury would appear to be high compared to a species like Thomson's gazelle, for instance, in which the fighting style is highly ritualized, usually involving only a harmless form of parry-and-thrust dueling.

Grant's males who learn to avoid fighting stronger individuals would have a greater chance of surviving to reproduce. By the same token, natural selection would favor the substitution of a ritualized display for dangerous combat. The adaptive significance of the neck display is that it is an effective and safe substitute for an actual trial of strength.

Yet in display contests between territorial males, neck size alone presumably does not determine the outcome. Since each member of the territorial network is, by definition, approximately equal to his neighbors, there should not be any pronounced differences between property owners. To win a place in the first instance, a buck must have the strength and determination to compete on equal terms with other territorial males, and he must remain equal if he is to maintain his position. Surely, no buck can afford to let himself be intimidated on his own property, for the certainty of being superior to all conspecifics on one's home ground is the essence of territoriality. Thus, brute force is no more important than motivation for preserving a balance of power, and indeed, since there may be considerable size differences between adjacent males, strength could be less important.

If physical endowment is not the decisive attribute in the neck display, how can conflicts between territorial males be resolved by display? It seems to me that what counts is execution. The vigor and conviction of the performance express the degree of self-confidence felt by the performer and determine the impressiveness of his display; in short, how he looks to an opponent depends on how he feels. Simply from the relative erectness and tension of each animal's bearing, it is often possible for an observer to judge which of two displaying bucks is more confident. If one holds his head higher and turns it more often and more vigorously, chances are that this animal will win the encounter—the other will give ground or withdraw altogether.

It is, however, often impossible to know the motivation, to understand why one animal should be dominant over another in a particular encounter. It is only safe to say that, in general, encounters that take place well inside a territory are won by the owner.

When two bucks display vigorously and with apparently equal self-assurance, there is always a chance that a fight will develop, but usually only after all the alternatives have been tried. Dr. Walther found that display bouts may last for as long as fifteen minutes and include up to three dozen head turns. Display bouts I have seen often became more intense the longer they continued. After the initial strutting and head turning from a distance, two equally matched bucks would begin to circle side-on and head to tail, coming closer while continuing to display. One or both would angle their heads so that their horns pointed in their opponent's direction. Sometimes they would march side by side for a distance, then stop to display anew, each drawing himself up to the fullest extent possible.

Between displays, each animal engaged in certain seemingly irrelevant behavior patterns—so-called displacement activities—such as scratching its neck, chest, or the area between the horns with a hind foot. They also grazed and performed the territorial marking display, emphasized by pawing the earth before urinating and defecating on the same spot. Horning the vegetation was also common during these encounters, and when addressed to an opponent could be interpreted as an aggressive threat.

If neither party is inclined to quit after a display repertoire of this kind, a fight is likely. In the final prelude, the pair stand confronting one another from a yard or less apart, necks low, ears spread, and horns presented vertically. They duck their heads up and down and touch horns, an act Walther fittingly terms "taking measure." Suddenly they surge forward, at the same time lowering their heads flat to the ground; the horns slide past each other and engage firmly at their bases, either interlocking or forked. In an effort to force the opponent backward or sideways, they push and strain against each other. Sometimes the horns become stuck together, leading to frantic efforts to pull away, during which they whirl around like a pair of square dancers. They may twist their necks and entangle their legs; their horns, in addition to dealing puncture wounds, can also trip them up. This is real combat now, and no one who has witnessed it can doubt the danger.

It is rare, however, for combat between mature males to become this violent or to last more than a few minutes. An encounter I watched last January was more typical. One of the bucks, decidedly less aggressive, simply gave ground, letting himself be moved back more than a hundred yards in a series of jousting encounters. Between shoving, the two ran through their display repertoire. Neither was hurt. Eventually they moved apart and ignored one another, although both remained in proximity and proceeded to herd the same group of females and young.

In extreme contrast to this encounter, the mortal combat I saw less than a week later began without preamble and was obviously serious from the outset. One buck—which may have been alarmed by the approach of my vehicle—trotted toward a group of adult males, females, and juveniles. Not expecting anything unusual, I didn't see the very beginning; the next thing I knew two of the bucks were hard at it.

The only explanation for this battle that seems to make any sense is that it was a grudge match, that

Horn configuration varies greatly among Grant's gazelle, from the lyrate, right, to the showier pattern and wider spread found in Ngorongoro.

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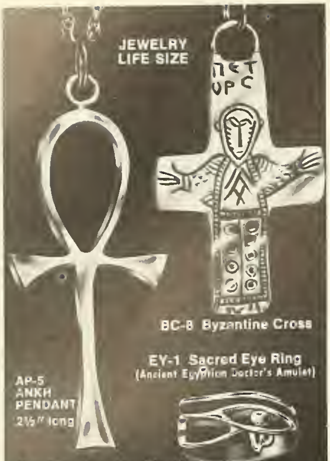
is, it was based on mutual antagonism growing out of the past relationship of these particular animals. Perhaps they had previously engaged in indecisive display bouts and fights and were now settling old scores. Maybe my approach forced the issue. Since I know nothing of their past history, this is, of course, pure speculation. I am not even sure they were territorial neighbors, although it appears likely. It is only certain that they were both fully mature, powerful animals, with endurance to match their rage.

At first I kept back for fear of disturbing them, but they were utterly absorbed in the conflict. It would have been extremely easy for a predator to grab one of them. In a place like Ngorongoro Crater this danger is enough to act as an added selective force against fighting. Maybe the same force also weeds out preoccupied fight spectators, for most of the nearby Grant's gazelle evinced little interest in the battle. Whatever the reason, there would appear to be no future at all in trying to impress Grant's does with a display of fighting prowess.

For a long time the bucks rammed and grappled with equal ferocity, neither gaining an advantage. Bound head to head by interforking horns, each tried to twist the other's head sideways and up and thus gain the leverage to throw him, the way a steer is bulldogged. Often their heads were rotated so far that the horn tips of one side actually stuck into the ground. Even at such an acute angle, neither quite lost his balance; in fact, the horn contacting the ground may have helped to prevent further twisting. If so, the animal with the wider horns would have been better protected against extreme twisting. One had a remarkably wide spread, while the other had more conventional close-set horns. I wonder whether one configuration does offer any mechanical advantage over another, in terms of grip or leverage. Assuming it does, then the great variation one sees among Grant's gazelle would suggest reduced selection pressure for efficient weapons and an increase in the importance of horns as ornaments of display.

While it may have had nothing to do with horn configuration, after about fifteen minutes the male with the close-set horns began to gain a



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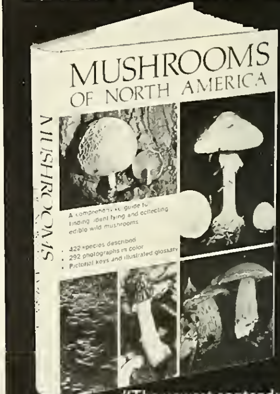

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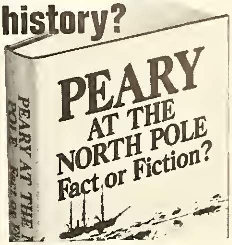
decisive advantage, along with the initiative. By then, both were exhausted but kept fighting. As they leaned against each other's necks, gasping for breath, the male with close-set horns was the first to break the long pauses. The wide-horned buck, simply reacting to his charges, pushed in return, but was obviously hard put to maintain his position. His only hope was to break free and make a run for it while he still had the strength; yet he gave every indication of sticking it out to the end.

And the end was near, for suddenly the other broke past his guard and began a furious onslaught upon his side and underbelly. That was when I intervened.

It was not out of pity so much as revulsion. At first, the vigor and savagery of the bucks was an exciting and beautiful spectacle, but as they continued, it began to seem brutal. The jarring impacts, the thrusts of the horns, the stertorous breathing, and the blood sickened me. When one was finally in a position to kill the other, I was unable to sit and watch it happen.

I jumped out of the car and ran toward them, shouting as loudly as I could. They paid no attention. Not until I was within a few yards did they break contact and run, the winner pursuing the loser. Fortunately, the wide-horned one could still run. He was nearly overtaken, but the winner gave up the chase within a few hundred yards and moved away some distance, limping slightly from a wound in one foreleg. Shortly thereafter, the wide-horned buck lay down. Returning later in the afternoon, I was relieved to see that neither seemed to have suffered any serious damage.

As I said in the beginning, I now regret my intervention. Partly because I was not involved in studying this species and partly because I felt that the animals were trapped in a highly unusual situation, I stepped outside the role of nonparticipating observer and let sentiment overcome scientific detachment. The thought that these two superb bucks lived to fight another day somewhat mitigates my sense of guilt. Did they resolve their differences, I wonder, or will they pursue them in another fight to the finish—next time without a referee? ☐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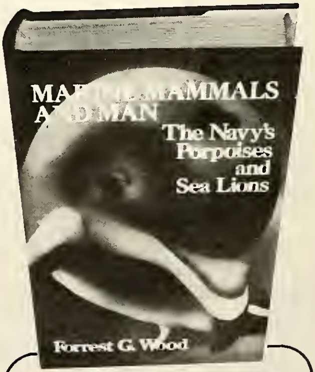

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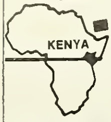

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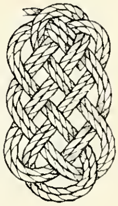

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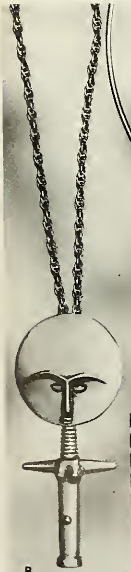

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The Day the Mountain Fell

Continued from page 68

barrier ridge and, like an incarnation of an apocalyptic beast, fell on Yungay and swallowed the city whole.

In that instant, more than 15,000 of Yungay's 19,000 citizens died, plus unknown thousands of Sunday visitors and vendors of farm produce. The city lay buried seventeen feet deep, like a modern Pompeii. Of the Plaza de Armas nothing remained but the tops of four palm trees. Whatever the great slide could not cover, it toppled; the church with its 36-foot belfry tower disappeared.

Huge boulders lay about: the largest, 14,000 tons, was left at the site of Ranrahinca. Most of the rock fragments were angular and fresh, as though torn from the outcrop. There were, however, many from previous landslides, apparently picked up and carried along by the Mount Huascarán avalanche. Geologists on the scene a few days later estimated that the total volume of solid material moved was 65 million cubic yards. This is more than one-quarter of the 240 million cubic yards excavated during the building of the Panama Canal.

The sudden and violent displacement and redeposit of immense masses of material had incalculable effects within the confines of the valley. In following the Rio Santa's course, the avalanche destroyed bridges, roads, communications facilities, fields, and power lines. But the greatest damage was human, and the Callejón de Huaylas lay like an open wound.

Peruvian air force pilots reported that visibility was hampered by clouds of dust from continuing avalanches, which mingled with the seasonal fogs of the Andes. There was, however, sufficient visibility to piece together a picture of survivors clinging to the mountainsides, valleys that had become raging rivers fed by burst dams, roads hidden under tons of rock, and scores of communities literally wiped off the face of the earth.

The disaster had been so precipitous, so complete, that it was days before its full impact was grasped. First accounts told of 200 casualties, but the toll climbed inexorably toward the thousands as additional stories were filed and as government spokesmen, reluctant to admit the worst, began to mention increasingly greater numbers, hazarding the outside possibility of 30,000 deaths.

The total was to be much higher. The true figures, delayed for weeks because of disrupted communications and ground routes blocked by landslides, were finally released at the beginning of July by Peru's National Emergency Committee: 70,000 lives lost; 50,000 injured; roughly 186,000 buildings, or 80 percent of those in the afflicted area, destroyed or rendered uninhabitable.

The generations for which the people of the Callejón de Huaylas had been spared a major earthquake were, at best, uneasy ones—marked by landslides that sacrificed a village here, a town there. Then, in a matter of minutes, a double tragedy enveloped all of the valley, and memories of the relatively peaceful years were obliterated.

A preliminary report made jointly by U.S. and Peruvian geologists soon after the disaster did not favor the rebuilding of Yungay and Ranrahinca and described Carás as being in one of the potentially most dangerous locations of any of the larger cities of the valley.

During the more than three years since the catastrophe of May 31, 1970, the government of Peru has not encouraged the restoration of the once picturesque cities and towns of the Callejón de Huaylas. The small amount of reconstruction that has taken place is largely the work of surviving residents reluctant to admit the finality of the event and start life elsewhere; but the ruins and rubble are a reminder that dominion over the landscape belongs to the forces of nature.

Meanwhile, there is apprehension among Peruvians that no place on the Pacific side of the Andes can be called truly safe. At their most extreme, these fears are typified by a centuries-old prophecy of an upheaval so great that one day vessels will be able to anchor in what is now the Plaza de Armas of Lima, eight and a half miles inland and 500 feet above sea level. ☐

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FUTURES FOR CHILDREN

Man's Age-old Struggle

If history is any guide, there's light at the end of the energy crisis

by Andrew Hardy

Many people fear that the disappearance of fossil fuels will doom civilization. They envision tractors paralyzed in the fields, highways choked with derelict cars, and factories ground to a halt. They pity our descendants, who, they imagine, will face everlasting drudgery. But history does not support such apocalyptic predictions. When "energy crises" occurred in the past and the main sources of power dwindled, society found alternative power sources.

The first "energy" shortage occurred during Paleolithic times, the result of man's too heavy reliance on a hunting and gathering economy that exploited resources without conserving or replacing them. Because Paleolithic hunting techniques were highly efficient, large animals eventually disappeared from regions where they could be hunted easily. Paleolithic people, however, did not lack food, for they were surrounded by edible plants. They probably also suspected a few basic principles of agriculture: that a seed, for example, grows into a mature plant. Faced with a shortage of animal food, man had to move on or die off or change the basis of his economy. Those who followed the last course developed agriculture. Anthropologists believe that the scarcity of food animals precipitated the Neolithic revolution.

Thousands of years later, ancient Rome met an energy crisis—a manpower shortage—by developing her waterpower. Human muscle had powered the ancient world. Organized masses of men constructed roads, aqueducts, buildings, canals, and other great works. The heavy machinery indispensable to such projects, the crane for example, was operated by gangs of soldiers on a treadmill. Wheels designed to pump water for irrigation or for draining mines were powered by men. Even flour mills employed human toil, although animals were also used.

It was not because they were ignorant of other sources of energy that the ancients depended so extensively on manpower. They knew well how to harness water. An Egyptian papyrus of the second century B.C. mentions a noria, a waterwheel used for irrigation. Strabo notes that King Mithridates of Pontus had a water-powered mill built in about 63 B.C. In the same period Antipater of Thessalonica hailed the arrival of the watermill:

> Cease from grinding, ye women who toil at the mill;
> Sleep late, even if the crowing cocks announce the dawn.
> For Demeter has ordered the nymphs to perform the work of your hands,
> And they, leaping down on the top of the wheel,
> Turn its axle, which, with its revolving spokes,
> Turns the heavy concave Nisyrian mill-stones.

Despite the ancients' familiarity with it, waterpower was little used until the fourth century A.D. Vested interests, economics, the geography of the Mediterranean, and snobbery prevented its earlier adoption.

As long as Rome enjoyed an abundance of manpower, she had a vested interest in preventing the employment of other kinds of power. The Romans, like the Luddites of early nineteenth-century England, reasoned that a man replaced by some other source of power would be deprived of a job and forced to become a parasite on society. The mob on the Roman grain dole was large enough without adding to it workers displaced by unorthodox technology. In consequence, the state discouraged daedal contraptions. Emperor Vespasian rejected an invention for transporting the columns for public buildings because many of the poor, who would otherwise have been on the dole, labored on such works. The wealthy owners of muscle-powered devices, having considerable political influence and wanting to protect their investments, also fought the use of waterpower.

The rivers around the Mediterranean posed another obstacle to the widespread adoption of waterpower; the volume of water they carried fluctuated wildly. Grinding would be restricted to the few weeks of the year when the water level was high. This difficulty could be surmounted by damming streams and constructing millraces

or Power

or by feeding the wheel from an aqueduct, but this demanded a substantial capital investment that financiers were unwilling to make because waterpower was considered a disreputable oddity.

In the classical age, affairs of technology and engineering were contemptuously associated with manual labor. Scientists, as men of good repute, were theoreticians; only under duress did they put their ideas into practice. Archimedes, for example, "though his [war machines built to protect Syracuse] had won him . . . fame for superhuman sagacity, would not consent to leave behind him any treatise on this subject, but regarding the work of an engineer and every art that ministers to the needs of life as ignoble and vulgar, he devoted his earnest efforts to those studies the subtlety and charm of which are not affected by the claims of necessity." This common attitude dissuaded both invention of, and investment in, new technology. Respectable men continued to invest in land and slaves.

The situation changed in the fourth century A.D. when the population of the empire plummeted. Rome diminished in size, and in Ostia the extensive tenement houses were replaced with single-family dwellings. The frontiers of the empire were abandoned. Manpower became scarce and costly. To hold down the price of flour, which was still ground by humans, Constantine assigned convicts to the grain mills. Thoughtful citizens, however, realized that this was only a stopgap measure. Authors began to praise the technological creativity of the barbarians and inveighed against the continuing indifference to the mechanical arts within the empire.

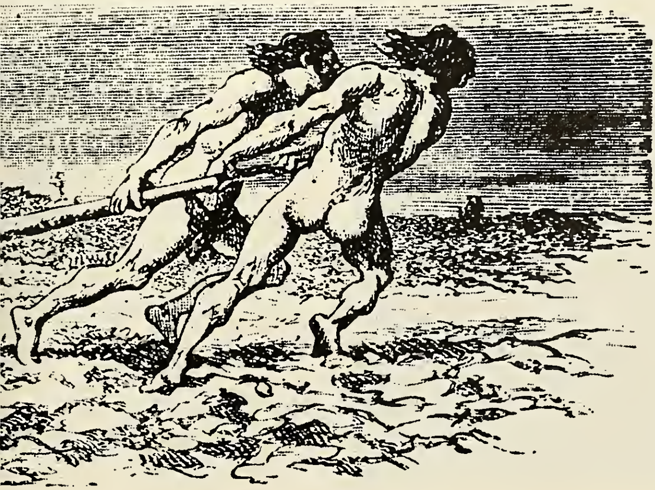
Faced with a shortage of manpower, the Romans eventually converted their mills to waterpower. By the end of the fourth century A.D., the mill owners' resistance to waterpower had subsided; they developed appropriate machinery and linked all the mills of Rome with the aqueducts. To insure that the power-hungry millers did not divert more than their share of water from the public system, subsequent emperors enacted detailed water-use regulations and appointed inspectors.

In time, waterpower came into use throughout the empire. A great flour factory was established near Arles. Sixteen wheels, mounted on the steep gradient of the aqueduct from Les Baux, ground 28 tons of flour in ten hours—or enough to feed 80,000 people. The factory supplied surrounding army camps and Rome as well. Other devices, such as irrigation pumps, were also converted to waterpower.

Twelve hundred years later, a shortage of wood laid the foundation for the Industrial Revolution. In 1610 "timber for building and other necessaries for husbandry [had] already grown so extreme dear" in Devonshire that supplies had to be imported from Ireland, Flanders, and Wales. The problem was particularly acute on the coast, where hardwoods were scarce in the first place. A petition to Elizabeth, advocating that mineral exports be forbidden, explained that "all the country villages . . . within twenty miles of the sea are . . . driven to burn of these [sea] coals, for that the most part of the woods are consumed."

During the Renaissance, wood was employed to an astonishing degree. Virtually everything—buildings, furniture, implements, containers, ornaments, ships, carts, industrial machinery, and weapons—was constructed of wood. Wood fueled every domestic and industrial fire. Caulking, soap, charcoal, vinegar, and alcohol were derived from it. Prodigious quantities of wood were devoured; the evaporation of 1,600 wagonloads of salt from brine consumed 6,000 wagonloads of wood. The preparation of a ton of bar iron from ore required twelve loads of charcoal, or about eight beech trees one foot square at the base.

The demands of a growing population for lumber and firewood, plus the requirements of expanding commerce for trade goods and conveyances, forced up the price of



The decline of game animals in the Paleolithic, man's first energy crisis, led to the development of agriculture and, in time, to the use of plows in turning the soil.

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wood more rapidly than the price of any other goods for which statistics are available. From the end of the sixteenth to the middle of the seventeenth century, prices in general multiplied three times; firewood went up eight times. High-quality wood for industry increased in price even faster: in 1605 the dyers of London were paying six times as much for dye wood as they had paid in 1550. The desperate Scottish "have been constrained not only to cut down and destroy their policy [parks] and planting, but also their movable timber-work, to make fire of it . . . and in many places the trade of brewing and baking for want of fire is neglected and cassen up [quashed]."

To meet the crisis, the government imposed conservation measures. An act of 1593 compelled beer exporters to either return the original barrels or to come back with foreign clapboard suitable for making the same number of barrels as had been exported. A royal proclamation of 1615, noting the alarming scarcity of wood, declared that "it were the less evil to reduce the times unto the ancient manner of drinking in Stone and of Lattice-windows, than to suffer the loss of such a treasure." Unfortunately, this approach required more wood than ever. More wood was used in baking the bricks for a building or in forging an iron container than in constructing the building or container out of wood itself. There was a much greater demand for firewood than for timber. As a result, coal was substituted as a power source.

Coal was cheap and plentiful, qualities that recommended it to everyone bedeviled by the costliness and scarcity of wood. Early in the seventeenth century, coal replaced wood fuel in the home and in some industries. In other industries, however, technical problems prevented immediate conversion from wood and charcoal to coal. New manufacturing techniques had to be invented before brickmakers, glassmakers, bakers, malt-dryers, lead-, tin-, copper-, and iron-smelters could take advantage of coal.

In the process of inventing new techniques, countless other discoveries were made. When the use of coal was finally mastered by these industries, the discoveries that had been made incidental to its mastery—along with the superior thermal efficiency of the new fuel—enabled factories to produce their wares in greater quantity at lower cost. Cheaper manufactured goods, particularly iron, could then be used more extensively for construction of machinery. Iron machines are not only much stronger than wooden ones, but some machines, such as steam engines, can only be made from iron.

As coal came into general use, demand for it rose. Yet production was limited by high overhead costs. Prospecting was uncertain: several shafts might have to be sunk before the vein was found; then water had to be pumped from the mine. The water- and horse-powered pumps in use until the eighteenth century had been designed for silver and copper mines and were not economical for coal mines. Neither the cost of diverting streams and rivers nor the cost of maintaining herds of horses was justified by the low price of coal. For example, it cost the partners of one colliery, who did not spend an extraordinary amount for drainage, an average of £26 per week for their pump horses. They received 2 to 4s. per ton of coal. The cost of pumping out a mine and the overhead of prospecting could not be absorbed by asking a higher price for coal; unless coal remained significantly cheaper than wood, people would not buy it. Wood was preferred; even after coal had become common, it was considered grimy and abhorrent.

The consequent economic squeeze between the cost of pumping and the most tolerable price for coal initiated a frenzied hunt for cheap pumping devices. From the reign of Elizabeth I through that of Charles I, one in seven patents dealt with pumping water. Inventors thought of all sorts of unlikely schemes. One group of experimenters sought to power pumping machinery by a jet of water vapor. Experiments with this curious source of power were unsuccessful throughout the seventeenth century until 1698 when Thomas Savery devised his steam-powered "miner's friend." This was rapidly succeeded by Newcomen's improved atmospheric engine. Although they were still crude and wasteful, these steam

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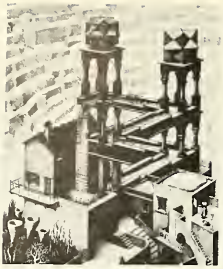

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engines slashed the cost of pumping. Accessible coal reserves were multiplied. Deep seams in the north of England, which had been abandoned earlier because of flooding, were mined again using steam engines. More coal meant cheaper coal, which in turn made iron and thus steam engines cheaper. This brought them within the means of more mines, so that more coal could be mined, and so on.

In addition to the problems of mining coal, the problems of hauling coal beleaguered seventeenth-century collieries. To keep costs down, coal had to be shipped in loads of unprecedented sizes. Abominable roads forestalled bulk transportation by land. Big cargoes had to travel by ship, and the need for bulk transportation of iron and coal resulted in the construction of a network of canals. If the mine lay any distance from a navigable waterway, overland transportation had to be furnished. Sleds, baskets, wheelbarrows, and wheeled carts were awkward. One expedient, first adopted in about 1600 by collieries on the Trent and Severn rivers, was to dispatch wagons on wooden rails down a gentle slope, and to pull the empty wagons back up on a similar railway.

By the eighteenth century, every large coalfield in Britain moved coal by horse-drawn railways; at the turn of the nineteenth century, the circuit of coal, iron, and steam was complete, and the first steam locomotives appeared on colliery railways. The coal industry had set the stage for a new order. The need for an alternative to wood fuel had provoked countless technical innovations and discoveries, culminating in the Industrial Revolution.

Perhaps we are now on the brink of yet another technological revolution. The historical shortages of large animal food, of manpower, and of wood proved beneficial in the long run. To secure alternative sources of power, people had to come to grips with their environment. The discoveries they made in the process of adapting the new power sources to society's needs bred a host of technological refinements. The energy shortage that we face also bids fair to stimulate new inventions and discoveries, as well as a new social order. □

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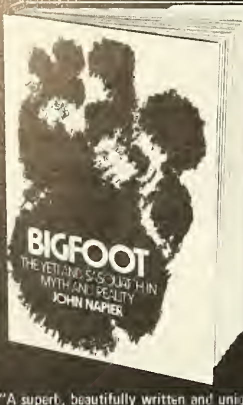

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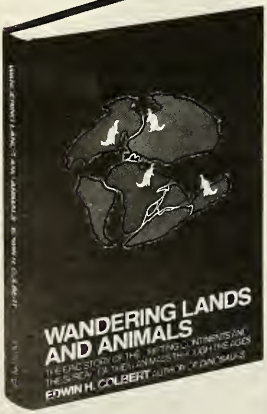
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Not All Roads Lead

Literature of the American Indian, by Thomas E. Sanders (Nippawanock) and Walter W. Peek (Metacomet). *Glencoe Press, $10.95; 534 pp.* The Sun Dance Religion: Power for the Powerless, by Joseph G. Jorgensen. *University of Chicago Press, $22.00; 360 pp., illus.* Americanizing the American Indians, edited by Francis P. Prucha. *Harvard University Press, $12.50; 358 pp.*

American Indians have been generally placid Uncle Tomahawks since their last resistance to white authority was broken by the massacre at Wounded Knee, South Dakota, in 1890. But the past year or so has seen them occupy the offices of the Bureau of Indian Affairs in Washington, D.C.; hold the town of Wounded Knee during a 71-day siege; kidnap the mayor of a New Mexico city; attack the courthouse at Custer, South Dakota; and in general display a new impatience with the terrible deprivations they suffer. Militancy, of course, was always one option open to the Indian in response to the white plague of European settlers spreading westward across the continent. Today it represents the best-publicized option, undoubtedly viewed with fear and loathing by whites in western states and secretly or openly admired even by acculturated Indians—yet it is much less widespread than the headlines indicate.

Traditionally, Indians have tended to elect one of three other options: (1) preservation of the rich Indian culture; (2) revitalization movements that seek power and redemption in the old ways, as witnessed by the peyote religion or the revival of the sun dance; and (3) accommodation to the white world. The three books under scrutiny in this review are concerned, in one way or another, with these options. Two of the books are directed primarily toward specialists, yet all three can be read with profit by those untutored in the disciplines of anthropology or Indian studies.

The most accessible of the three is *Literature of the American Indian,* which I believe is the soundest collection yet published of Indian myths, poems, oratory, laws, rituals, and autobiography—all interlaced with lucid and thought-provoking commentary by authors who are, at least in part, of Indian ancestry. Both Nippawanock and Metacomet have gone through the various stages of assimilation into white society while at the same time seeking the roots of their "Indianness." Both have felt the humiliation and shame of holding an ambiguous position in modern America, which has given them the breadth of understanding to approach a book concerned with the first option listed above. They have undertaken an ambitious task: to explain the ways of Indians to a primarily white readership by offering both wide-ranging excerpts from native literature (mostly oral) and editorial comments. The selections, largely unknown to most people, are generally well chosen and offer a freshening experience for the reader.

Given the intrinsic problems of their task, and these are overwhelming, the authors have succeeded admirably. The dual difficulties they encounter—which few by Peter Farb

to Wounded Knee

anthologizers of Indian literature have faced up to or even acknowledged—are the questionable authenticity of many of the texts and the difficulty of conveying in English translation even those texts that are above suspicion. The authors document the translation difficulty by analyzing a short Chippewa "Chant to the Firefly," first in its original language, then in a word-for-word translation, and finally in a literary translation by Henry Rowe Schoolcraft (the pioneer explorer and ethnologist who is remembered chiefly for his discovery of the source of the Mississippi River and also for his collection of Chippewa legends, which Longfellow mutilated in *Hiawatha*). Schoolcraft translated the first two lines of the chant as:

> Firefly, firefly: bright little thing,
> Light me to bed, and my song
> I will sing,

which is quite ludicrous, as anyone with even a smattering of Indian languages can attest.

But the authors also demonstrate the inadequacy of a literal translation: "Flitting-white-fire-insect: waving-white-fire-bug: give me light before I go to bed." The words translated as "insect" and "bug" scarcely hint at the complex cultural attitude held by the Chippewa toward all living things, particularly their intellectual-emotional response to a fire-being. "Bed," also, is a European concept and no adequate way exists in English to express the meaning of the original Chippewa idea of repose. I dwell on this particular linguistic example because it typifies the problems faced by any anthologizer attempting to recover in one language the literate past of people who spoke in other languages, and also because it demonstrates the admirable clearheadedness with which the authors approach their task. Their detailed introductions to the sections on creation accounts, folk tales, oratory, and rituals are equally perceptive.

The Sun Dance Religion, by Jorgensen, is a study in depth of the second option. Meticulously documented, displaying awesome scholarship, it tells how small groups of Indians in Utah, Idaho, Wyoming, and Colorado have attempted to counter their modern plight by reviving an ancient ritual. Although it probably tells more about the sun dance of the Great Basin Ute and Shoshoni than the nonspecialist will care to know, it undoubtedly will become a minor anthropological classic.

The sun dance was apparently invented by the Cheyenne about 1700 and within 50 years had spread rapidly. It soon became the grandest of the native religious ceremonies, one intended to insure success in warfare or on the bison hunt; it was painted by Catlin and memorably described by many explorers. But by the end of the last century it had virtually vanished—as had the bison, the native cultures, and many of the Indians themselves.

About 1900, the sun dance was reborn among the Shoshoni of Wyoming, who dropped the war and hunting features and substituted a concept of *puwa*, which might be loosely translated as "a supernatural power or force that exists in all living things." The reshaped dance incorporated some Christian

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symbolism, but primarily it shifted the emphasis toward unifying the Indian community. The participants dance for three days and three nights, without food or water, accompanied by drummers and singers. Prominent Indians deliver orations, exhorting both the dancers and the audience to remember the old ways, to maintain the obligations of Indians toward one another, and to shun the immorality of whites.

The sun dance now flourishes as the major religious movement on several western reservations, where it claims more adherents than the peyote religion. Those who dance receive the gift of redemption through a transformation of their personality—becoming, in the process, stronger, more responsible, and more selfless in behavior toward all Indians. The dancers reject the evils of white society and maintain their Indian identity in the face of the overwhelming numerical, technological, economic, and political power of whites. The sun dance, though, is only the beginning for the initiate; he has started on a long and arduous journey that demands fortitude. But the reward the dance promises is an improved life for himself and for all Indians.

If this book has a failing, it lies in its inability to hurdle the thicket of detail that resulted from Jorgensen's quarter century of interest in the sun dance, beginning with his boyhood in Utah. Scant effort is made to compare and contrast this redemptive movement with the peyote religion, the Ghost Dance, the Iroquois Code of Handsome Lake, or other such movements in North America—or with similar phenomena among deprived peoples on every continent, which have been documented as far back as biblical times. Indeed, American Indians are now witnessing a revival of native religions (until quite recently outlawed by the federal government), which may eventually become a greater source of pan-Indian solidarity than that offered by some of the militant organizations. Cutting across tribal and linguistic barriers, these religions are truly an ecumenical force that may build the base for Indian unity.

In the remaining space in this review I will briefly acknowledge the

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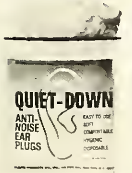

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publication of *Americanizing the American Indians*, a collection of documents authored by white reformers who called themselves "the friends of the Indian." They sought, particularly in the years 1880–1900, to assimilate Indians into the "civilization" of the American mainstream—and in the process to destroy Indianness. Considering that the documents reprinted here are all in the public domain, that the book is simple and uninspired in format, and that it lacks a single illustration, assuredly the $12.50 price represents a monumental rip-off.

This is unfortunate, considering the gems of naïveté to be found in the writings of these reformers who goodheartedly and exuberantly worked to transform Indians into replicas of white citizens. Here can be found case after case of sympathetic whites to whom it never occurred to ask the Indian what he wanted for himself or even to inquire into the richness of his culture to help him preserve its tattered remnants. Instead, the goal, as one Commissioner of Indian Affairs put it with disarming ingenuousness, was to make the Indian feel at home in America. The volume is filled with such documents, but, surprisingly, no mention is made of the Indian counterparts to the white reformers, those red men who chose option three and accommodated themselves and their people to the various white prescriptions for the native Americans.

Today, Indian lands and resources are still being grabbed by land-hungry whites. But in place of greedy pioneers and cavalry, Indians now must face the legal batteries of monster corporations that build power plants on Indian lands, lay railroad spurs and truck routes through reservations, erect housing developments (whites only need apply) on their lands, or bare the bones of the sacred earth to strip-mine coal. These acts are bloodless massacres, with a modern twist, of the Indian spirit, integrity, and economic well-being. They are usually committed with the collaboration of those federal officials whose job it is to protect the Indians and of accommodating Indians themselves. No wonder we are now seeing protests such as the seizure of Wounded Knee, the resurgence of native reli-

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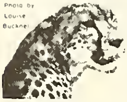
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gions, and the search for a very glorious past.

Peter Farb has written widely about anthropology and the American Indian. His latest book, Word Play: What Happens When People Talk, *will be published in January, 1974.*

MUST THE SEAS DIE? by Colin Moorcraft. *Gambit Publishers, $6.95; 194 pp., illus.* THE EDGE OF AN UNFAMILIAR WORLD, by Susan Schlee, *E.P. Dutton & Co., $10.95; 397 pp., illus.*

All these two books have in common is that they are both about the sea: the first is a plea for saving the oceans as a life-sustaining environment; the other, a look at the questions marine scientists have asked over the last 100 years and a well-documented description of how they went about obtaining answers.

Colin Moorcraft's book first appeared in a British version in 1972: it is written with skill and verve and it espouses a worthy cause. Since he wrote for the layman, a scientist reviewer finds some statements too sweeping and some explanations of cause and effect connections just a bit thin. I know how difficult it is to avoid these pitfalls and I want to let this statement stand more as a caution than as a criticism.

About half of the book's fifteen chapters deal with generic problems—the oceans as a source of food, overfishing, and pollutants of various kinds. The other half takes the regional approach—marginal seas, the Arctic and the Tropics, and the Pacific, Indian, and Atlantic Oceans. With such a division some repetition and overlap is unavoidable, but not necessarily a detriment. After all, if something is worth saying once, one may well say it twice or more in the same work. Moorcraft has buttressed his two-pronged approach to the plight of the oceans with a good, sweeping introduction and a "what can we do about it" ending. In the former, he tries to come to grips with what is likely to be the key problem of the second half of the twentieth century—a late awakening to the delayed dysfunction of economic

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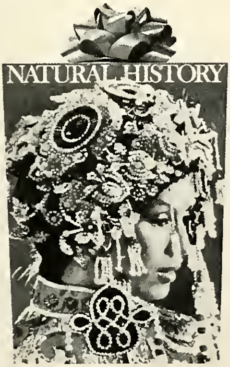

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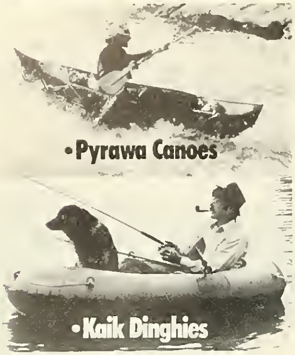

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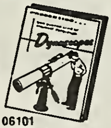

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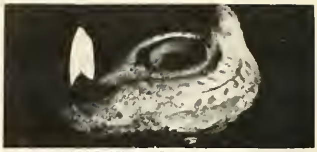
growth that relies heavily on various facets of the environment as free goods. He points out that the seas are the universal sink, but alas, they have no stoppers or automatic disposal units beneath them. Consequently, unless we, the high technology, affluent resource users and elaborators mend our ways, we will pay heavily in the future for not acting on the early warning signals we have received.

Moorcraft implies, but could state more succinctly, that there are two kinds of pollution problems in the sea—spot sources, such as oil spills, and global fallout phenomena. The two are not divisible in a hard and fast way; oil is a good case in point for it emanates from a spot, be it a bilge pumped in mid-ocean or a runaway well like Santa Barbara's, but its physical nature makes it spread and it has undecomposable residues. The tar globules which Heyerdahl encountered in mid-Atlantic on his *Ra* voyages, for instance, are likely to stay around for a long time, and we really do not know what their ecological effects might be.

It is the spot sources of land origin that give us the most trouble, hence the violent transformations of inland—or marginal—seas, including bays, estuaries, and even coral reef areas. The Baltic is perhaps beyond redemption, at least on a time scale of one or two human generations, and the Mediterranean and the beautiful Inland Sea of Japan are close seconds, not to speak of better known examples nearer at hand, such as Tampa Bay and the Hudson estuary.

And what about the large ocean basins? How far has the blight spread? Moorcraft tries to answer these questions in one short chapter and not too satisfactorily at that. The problem is that we just don't know. We should, however, avoid crying wolf too often while we try, in an integrated and painstaking fashion, to unravel the intricacies of man's influence on mid-ocean biology in surface as well as deeper layers of the sea. I believe, for instance, that the large tuna and swordfish mercury scare will turn out to have been such a case of crying wolf; examination of old museum samples and comparison with recently caught fish revealed no statistical differences in mercury load-



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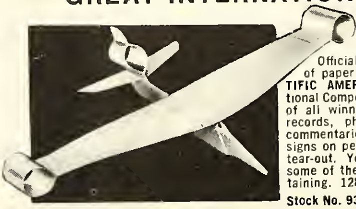

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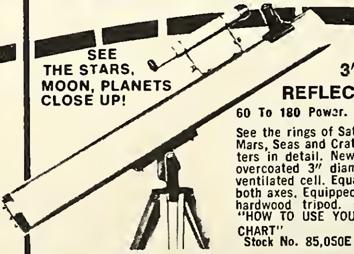

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ing between the two. The early samples were, of course, taken before man accelerated the turnover of mercury in the biosphere, and so one must conclude that it is indeed "the nature of the beast," its filtering of enormous quantities of seawater, and the age-old existence of bacteria that transform inorganic into organic mercury that are at the root of the problem. While we can therefore indulge in the occasional swordfish steak if we eat no other high-mercury foods concurrently, this is no excuse for voiding mercury compounds into rivers or bays as at Minamata or Nigata in Japan, at Sarnia, Ontario, or in Sweden where there resulted local catastrophies affecting all forms of life, including man. But these, one may trust, will not recur, now that we have learned more about mercury in the school of hard knocks.

Must the Seas Die? is a good and worthwhile book. It says little that has not been said before, albeit in writings less accessible to the general public. The warning it sounds is timely and likely to remain so. It is not the author's fault that its final chapters, "Immediate Action," "Long Term Action," and "What You Can Do," are far from satisfactory. Human society simply has not come to grips with the environmental problems it has created and, to some of us, seems singularly shortsighted and reluctant to do so.

Susan Schlee's history of oceanography is a "sea horse of a different color." I wonder for what kind of reader she has written it? The paragraphs on the cover flap suggest that it is an exciting book. It has not excited me, perhaps because I know too much about the subject matter; but then I also know something about molecular biology and yet *The Double Helix* was exciting reading, having woven a rich tapestry of the warp of science and the woof of the scientists' lives and foibles. The comparison is a bit unfair, I admit, because the unraveling of the structure of DNA was a single problem that involved relatively few contemporary people whom the author knew, while Susan Schlee is dealing with a century and many men, most of them dead, few of her acquaintance, as well as a welter of large scientific questions and problems.

Still, a historian will be judged

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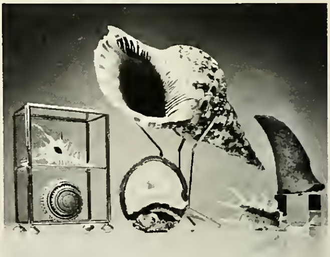

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by his or her ability to make the past live, and since I was not as convinced as the cover flap writer that Schlee had accomplished this feat, I gave the book to a young biology teacher interested in oceanography and asked her for her opinion. She told me that while she found it a source book of considerable completeness, she had to force herself to read on. When she reached the latter third, things began to pick up. Even then she felt the book did not convey to her the enthusiasm and dedication of the men who pioneered the breakthroughs that shed light on the oceans' importance to man.

Perhaps Schlee really intended to write a systematic compilation of facts about men and the methods they used—in this she succeeded. Sitting in Woods Hole as she does, it would have been valuable had she pumped her mentors more than she did. For then, instead of ending her book with "and that . . . is where oceanography is today—at a point in its growth as a group of closely related sciences where it is recognized as being worth a great effort and productive of profound results," she might have added a perspective of where oceanography might or should be going—also a task of the historian—and one that she could have tackled by talking to some of the great oceanographers with whom she must rub elbows day in and day out. All in all, though, the book, well documented as it is, will still be useful as a reference.

John E. Bardach
Hawaii Institute of Marine Biology

In the August-September issue, *Natural History* used a picture caption on page 60 that inadvertently implied that Manila hemp and *Cannabis* are related. Manila hemp comes from the leaves of a relative of the banana, not from the marijuana plant. The author had no role in this erroneous impression, which was wholly the responsibility of the magazine.

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For a copy of "The glass container story," write: Glass Container Manufacturers Institute, Dept. E, 1800 K Street, N.W., Washington, D.C. 20006.

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Beginnings and Ends of the Earth

Stars, like people, do not live forever. But the lifetime of a person is measured in decades; the lifetime of a star in billions of years.

A star is born out of interstellar clouds of gas and dust. For a while, it stably converts hydrogen to helium in the thermonuclear furnaces of its deep interior. Then, in stellar old age, it encounters a set of minor or major catastrophes—a slow trickle or an explosive injection of star-stuff into space. During the more or less stable portion of the lifetime of the star, the hot interior region, converting hydrogen into helium, gradually eats its way outward from the very center. In the course of time, the star becomes slowly, almost imperceptibly, brighter.

After the flares and other impetuosities of its early adolescence, our sun settled down to a more or less constant radiation output. But four billion years ago it was about 30 percent dimmer than it is today. If we assume that the earth four billion years ago had the same distribution of land and water, clouds and polar ice, so that it absorbed the same relative amount of sunlight that it does today, and if we also assume that it had the same atmosphere it has today, we can calculate what its temperature would have been. The calculation reveals a temperature for the entire earth significantly below the freezing point of seawater. In fact, even two billion years ago, under these assumptions, the sun would not have been bright enough to keep the earth above the freezing point.

But we have a wide variety of evidence that this was not the case. There are in old mud deposits ripple marks caused by liquid water. There are pillow lavas produced by undersea volcanoes. There are enormous sedimentary deposits that can only be produced on ocean margins. There are biological products, called algal stromatolites, that can only be produced in water.

So what is wrong? Either our theory of the evolution of the sun is wrong or our assumption that the early earth was like the present earth is wrong. The theory of solar evolution seems to be in good shape. What uncertainties exist do not appear to affect the question of the sun's early luminosity.

The most likely resolution of this apparent paradox is that something was different on the early earth. After studying a wide range of possibilities, I conclude that what was different, two billion years ago and earlier, was the presence of small quantities of ammonia in the earth's atmosphere. Ammonia is present on Jupiter today; it is the form of nitrogen expected under primitive conditions. It absorbs very strongly at the infrared wavelengths that the earth emits to space. Ammonia on the primitive earth would have held heat in, increasing the surface temperature through the greenhouse effect and keeping the global temperature of earth at congenial levels. Ammonia would have made possible the origin and early history of life and the abundance of liquid water early in the history of the planet. Ammonia is one of the atmospheric constituents needed for making the building blocks of life. The study of the sun's evolution leads us to information about the early history, chemical composition, and temperature of the earth, and therefore, to the circumstances of its habitability. Stellar and biological evolution are connected.

What about the future evolution of the sun? The sun is steadily growing brighter. About four billion years from now the sun will be sufficiently bright to cause a runaway greenhouse effect on earth, just as there is today on Venus. Our oceans will boil, and carbon dioxide, now present as carbonates in the sedimentary rocks, will pour out into the atmosphere. The earth will become an uninhabitable caldron.

It is conceivable that the technology of those far distant future times will be equal to the task of preventing such a runaway, but it will be an extremely difficult engineering job. However, the same increase in the brightness of the sun some billions of years from now will convert Mars from a place where the average temperature is 100°F. below zero to a place that has temperatures almost exactly the same as those on earth today.

When the earth becomes uninhabitable, Mars will gain a balmy and clement climate. Our remote descendants, if any, may wish to take advantage of this coincidence.

From The Cosmic Connection: An Extraterrestrial Perspective. *Copyright © 1973 by Carl Sagan and Jerome Agel.*
To be published in November by Doubleday & Company, Inc.

Celestial Events

by Thomas D. Nicholson

Sun and Moon The days are rapidly growing shorter and the nights longer in October and November. Daylight shrinks nearly 2½ minutes per day, from about 11 hours 12 minutes in length in mid-October to 9 hours 59 minutes in mid-November.

The moon is in the morning sky in mid-October, as a gibbous moon rising before midnight, a first-quarter moon on October 18, and as a waning crescent in the dawn sky for at least three following mornings. After new moon on October 25, you may expect to see the crescent moon in the evening sky by the 28th, growing in size and remaining later each night. First-quarter moon is on November 3; from then until full moon on November 10, the gibbous moon will be well up at sundown and will remain till well past midnight. From the 10th to the 15th of November, the waning gibbous moon again brightens the sky from before midnight until dawn.

Stars and Planets In October and November, you can still find the brightest of the summer stars well up in the west after dark. The autumn stars, spread around the easily recognized Square of Pegasus, are high in the south. But just a few hours later, well before midnight, Taurus, Auriga, Orion, and Gemini, and their brilliant winter stars, are making their debut in the east.

This autumn, bright planets make for a dazzling evening sky. Just an hour after sundown, you will find Venus low in the southwest, Jupiter high in the south, and Mars well up in the east. Except for the moon they are the three brightest objects in the sky. Venus is by far the brightest of the three, and you can tell Mars by its reddish yellow color.

October 16: Mars is nearest earth, at a distance of 40,532,000 miles. The planet approaches the earth most closely about every 2 years 2 months, and while this is not one of the very best approaches to us, it is good enough to make Mars brighter than Jupiter.

October 17: Saturn is stationary in Gemini and begins its retrograde (westward) motion. The moon occults Saturn at about 6:00 A.M. EST, and the occultation will be visible in the skies above northern North America.

October 18: Mercury is at its greatest distance east of the sun in the evening sky, barely above the western horizon at sundown.

October 21: The Orionid meteor shower may be seen during early morning hours today and tomorrow. Expect up to 20 shower meteors per hour.

October 24: Mars, at opposition, will be in the sky all night.

October 29–30: Venus will be close to the moon on both evenings.

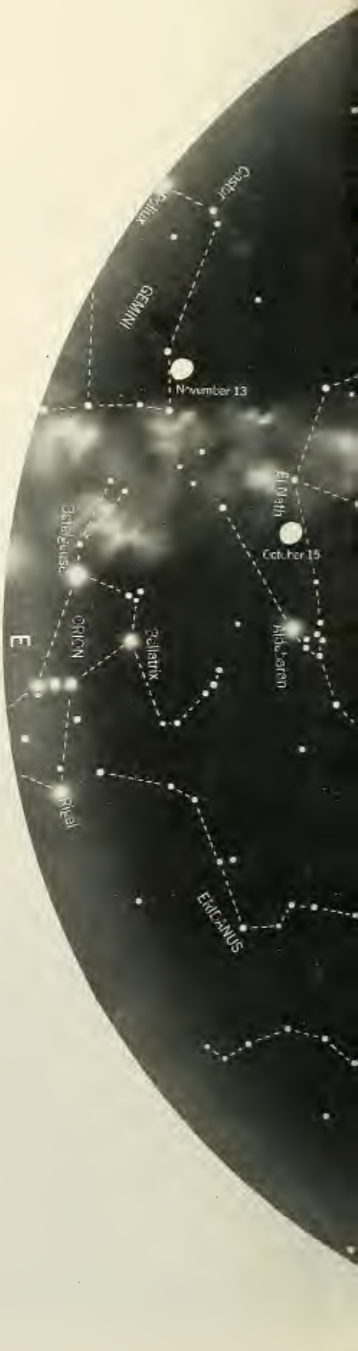
October 30: Mercury begins its retrograde motion on the way to inferior conjunction with the sun.

November 4: Meteors of the Taurid shower may be seen for about a week before and after this date. But it is a weak shower (less than 15 per hour) of not-too-bright objects.

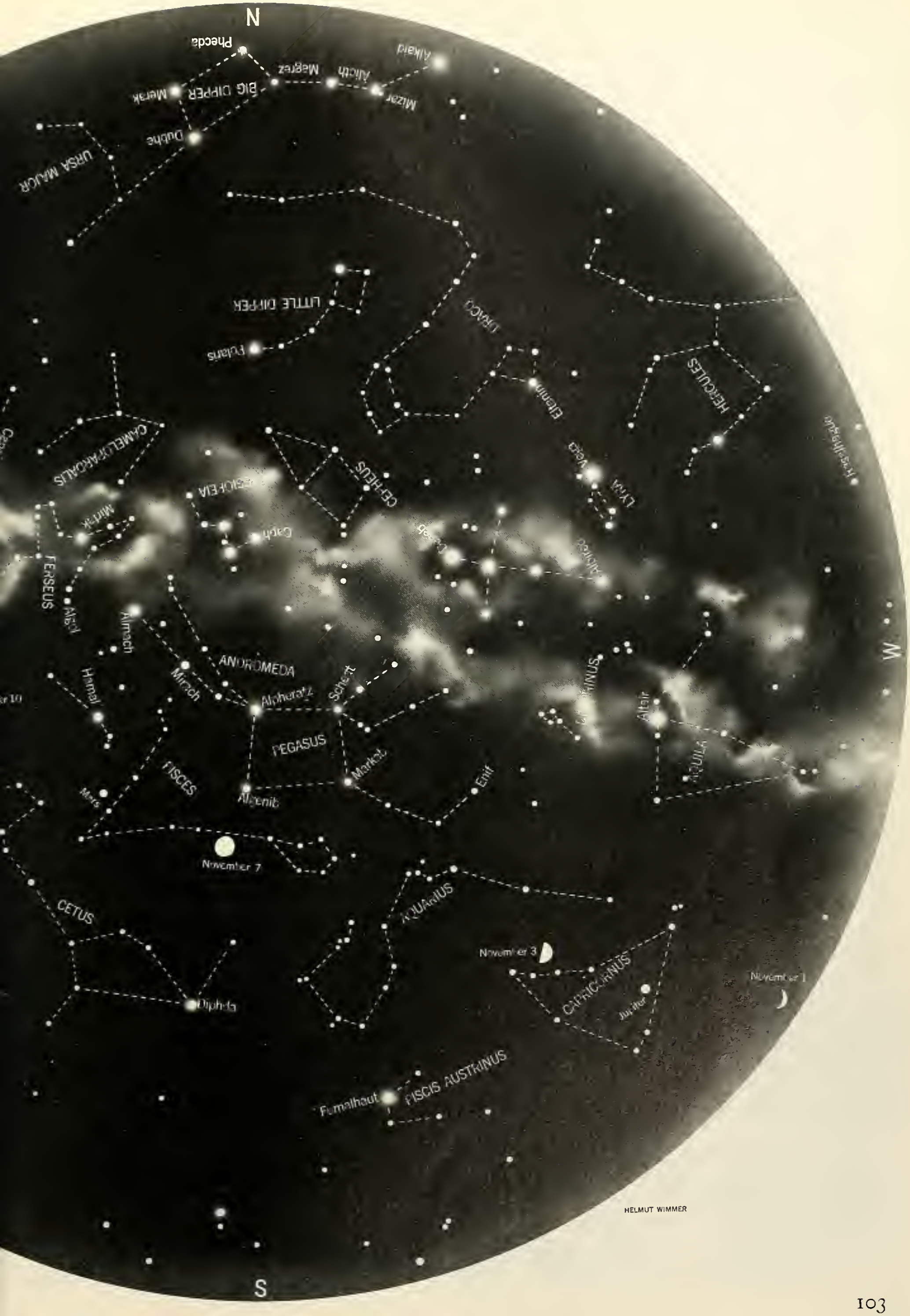
November 8: Mars is near the moon all night, closest at 2:00 A.M. on the 9th.

November 10: Mercury is at inferior conjunction, passing between the earth and the sun. At sunrise this morning, you may be able to see the planet as a tiny black dot against the sun's face, moving away from the right edge of the sun.

November 13: Saturn, in the morning sky today, is near the moon. Venus, in the evening sky, is at greatest elongation (distance east of the sun).



★ Hold the Star Map so the direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:20 P.M. on October 15; 9:20 P.M. on October 31; and 8:20 P.M. on November 15; but it can be used for an hour before and after these times.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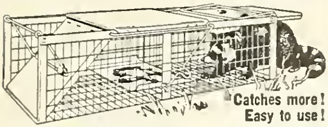

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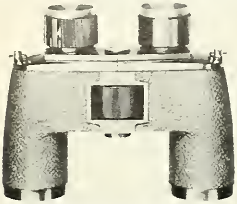

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SECRETS OF THE GREAT PLANT WIZARD

LUTHER BURBANK: PLANT MAGICIAN. J. Y. Beaty. Julian Messner. New York, 1943.

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THE DAY THE MOUNTAIN FELL

EARTHQUAKES AND EARTH STRUCTURE. J. H. Hodgson. Prentice-Hall, Inc., Englewood Cliffs, 1964.

EARTHQUAKES 1969. Environmental Science Services Administration. U.S. Government Printing office, Washington, 1969.

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SHOWDOWN IN NGORONGORO CRATER

THE LONG AFRICAN DAY. Norman Myers. Macmillan Publishing Company, Inc., New York, 1972.

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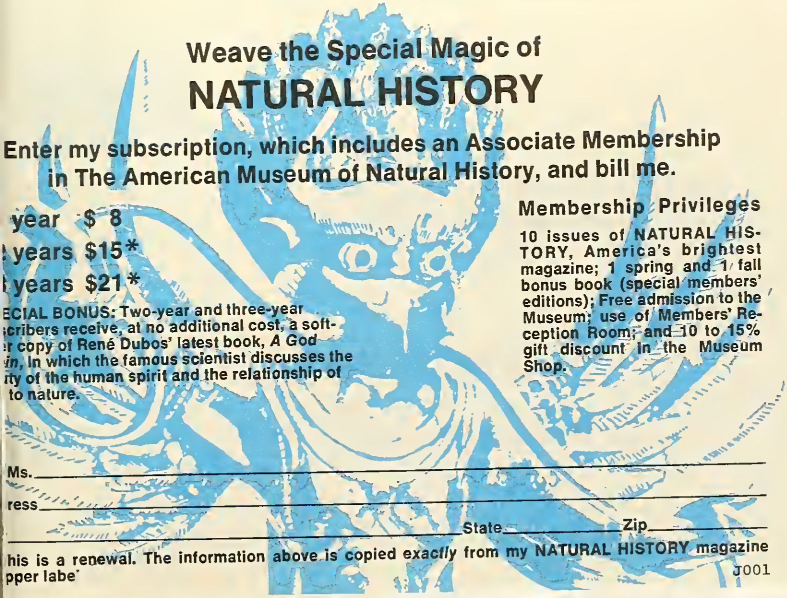

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Despite pressure from governments, Middle East nomads have been reluctant to settle down. Maybe they shouldn't.

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"After all, anyone who characterizes Iowa as 'among the most mismanaged lands in the world' can hardly be all bad."

126 Celestial Events
Thomas D. Nicholson

Cover: *In New York's Westchester County—near the heart of Megalopolis—two boys are oblivious to civilization as they pursue their woodland adventures. Photograph by Angela Soccodato. The Metro Forest, a special supplement, begins on page 45.*

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But money can be hard to come by in the inner city and we urge other businesses to help minority banks with regular deposits. Because sometimes it's nice to build things—besides interest.

EXXON

Authors

A meteorologist as well as a physicist, **K. Ya. Kondratyev** is head of the Department of Atmospheric Physics at the University of Leningrad and a corresponding member of the USSR Academy of Science. He is the author of several books on atmospheric radiation.

O. I. Smokty, a senior scientific collaborator at the Hydrometeorological Institute in Leningrad, is an expert on the theory of multiple scattering in the atmosphere. Both men took their Ph.D. degrees at the University of Leningrad in 1948.

K. Ya. Kondratyev and O. I. Smokty

As editor of the New York Botanical Garden's newsletter, **Frank J. Anderson** spends much of his time doing research in libraries, where he often comes across descriptions of early natural history collections. Anderson is the author of "Medieval Beasties," which appeared in *Natural History*, January, 1973. He is currently working on an illustrated survey of printed herbals, and is planning a study of man's response to nature as revealed in his art.

For a combined total of 26 years, **Gerald A. Wunz**, project leader with the Pennsylvania Game Commission, and **Arnold H. Hayden**, research biologist with the Commission, have studied wild turkeys and methods of increasing their numbers. Wunz has analyzed the effect of habitat changes on turkey populations, while Hayden has evaluated the effects of clear-cutting on turkey adaptation. Hayden plans to measure the impact of summer cottages, hunting camps, and snowmobiling on the birds' ranges, while Wunz is continuing the work he began in 1966 to determine the limits of turkey tolerance to human disturbance.

Gerald A. Wunz

Arnold H. Hayden

For two years, **Donald P. Cole** lived among the Bedouins of Saudi Arabia while he studied the kinship and marriage practices of traditional nomadic tribes. His research included the nomads' adaptation to the rapid social and economic changes in the country. Cole, who teaches anthropology at the American University in Cairo, plans future studies on kinship and nomadic-sedentary relationships among other Middle Eastern tribes.

Donald P. Cole

Information about the authors of this month's supplement appears on page 84. ☐

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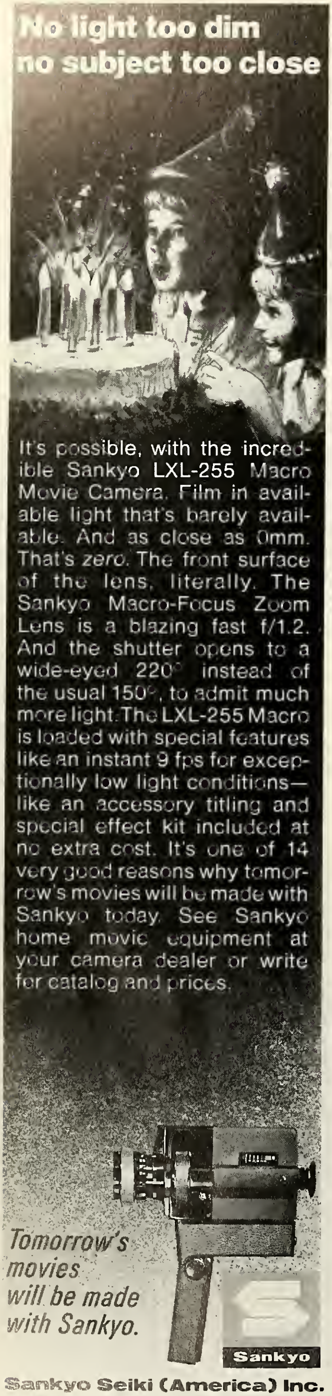
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Letters

Sunny Side of Life

Your recent article "The Rites of Summer," [August-September, 1973] which revolves around the suntan and its time and place in history, was well written by a man who evidently prefers to stay out of the sun.

I am a longtime southern California naturalist, and my work awards me almost continuous contact with the sun—in the deserts, mountains, and seashore. I have a year-round suntan. But the sun does more than tan your hide. It sinks into the innermost parts of your being and exerts a tranquilizing effect that is close to being spiritual. To avoid the sun, which makes all life possible, is to avoid life itself.

I must agree with the author that a suntan in many parts of the world is a status symbol. It denotes considerable leisure time and separates suntanned people from the millions of people locked in their individual cages for eight hours a day, five days a week.

I may die of skin cancer, but unlike the author of this article, I will not die of prostatitis, stomach ulcers, or lung cancer.

Cecil E. Johnson
Professor of Biology
Riverside, California

Dog Days

Your article about Morris [August-September, 1973] brought back many memories of my dachshund, who lived to be thirteen.

I also had pulled the ball switcheroo trick only because of my preference for a dry tennis ball instead of a wet goopy one. But you are right! The dry one (ball B) is practically nonexistent.

I also remember the minutes passing by as each part of the ground was sniffed on the way back from getting the ball. My dog was a little different though; he would sniff the juiciest spot (or spots) from the previous throw. The fast tail-wagging was the best part of all.

And I never did figure out how my dog never had a nose and lungs full of dirt and gravel, or at least a raw nose. But he would huff and puff with his lips spasmodically billowing like a balloon.

Thanks for a really special article.

Claudette Winkler
North Andover, Massachusetts

To Feed a Hummingbird

I offer this letter to the editor because of the many questions that have been asked me by hummingbird enthusiasts. Perhaps I can use this vehicle to shed some light on the mechanism by which they feed, the best food to offer (honey vs. cane sugar, boiling or not boiling the food), and how to attract the birds to the food.

When not confronted by man, hummingbirds obtain most of their food from the nectar in flowers, and Dr. Larry Wolf and I have been studying this relationship for several years. Contrary to some beliefs, the birds do not appear to obtain insects from the flowers. We have examined some 40 to 50 species of flowers, and the only persistent insects that we have found are mites that live in the nasal passages of hummingbirds. Although insects are probably an important source of protein in the diet of hummingbirds, the birds appear to obtain most of their calories from nectar.

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Flower nectar is a simple sugar solution consisting usually of sucrose, glucose, and fructose. Since a sucrose molecule is composed of a glucose and a fructose molecule linked together, a solution of cane sugar (sucrose) would serve to mimic what the flowers offer. Use of honey, a similar source of carbohydrates, may serve to retard spoilage, but it is not necessary.

Hummingbirds consume nectar by licking with their tongues (*not* by sucking) 3 or 4 times per second. The tongue is forked at the tip and contains a groove at the top, which fills with nectar. This groove, open at the top and closed at the end, precludes sucking as a way to consume nectar. When the birds visit flowers, they empty them of nectar by protruding the tongue several times without getting a full tongue full of nectar. When visiting a feeder, there is always a large volume of "nectar" available every time the tongue is protruded; as a result feeders are more efficient to visit in terms of the quantity of fluid obtained by the birds for the period of time they must hover.

The birds should be attracted to feeders containing sugar solutions of the same concentration as the nectar in flowers. To date, we have measured the concentration of nectar from twenty-eight species of flowers hummingbirds are known to visit in the United States. The concentration varies from species to species, but most of the flowers offer nectar that is equivalent to approximately a one-third solution of sugar by weight. Such a solution in a feeder would offer the birds about what they are getting from flowers and the increased efficiency of feeding at a feeder may serve to attract the birds from their more natural floral source of energy.

F. REED HAINSWORTH
Associate Professor
Department of Biology
Syracuse University

Beaches of Nosara

One of your readers complained about the number of advertisements in *Natural History* sponsored by land developers [May, 1973]. As the developers of the Beaches of Nosara in Costa Rica, we advertise in *Natural History* to attract potential homesite buyers. We think it

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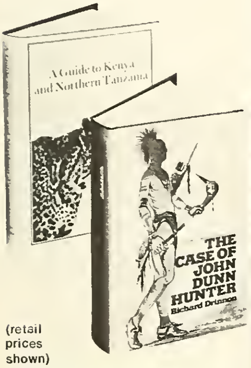
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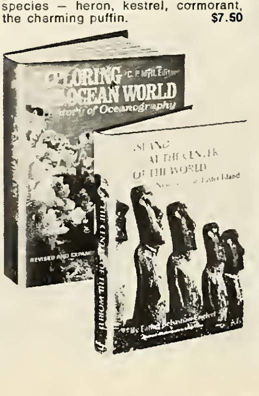
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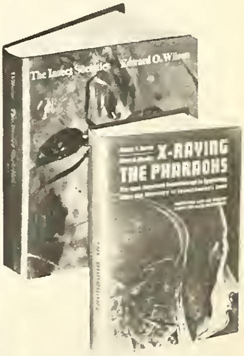

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The establishment of ecologically balanced recreational and retirement communities in Central America is not going to solve the serious land use problems of the area, but in individual cases it can lead to the preservation of at least a representative sample of an endangered ecosystem and provide enough local employment to replace or offset subsistence farming.

At the Beaches of Nosara we have worked with the Tropical Science Center of San José, Costa Rica, to create an ecologically balanced community. We have set aside forest and wildlife reserve areas, stopped annual burning of pasture land, and enforced "no hunting" regulations . . . and it's working! Our workmen and their families and neighbors in the nearby village of Boca de Nosara have become more conservation conscious because they can see the economic benefits for themselves. Our homesite owners, many of them *Natural History* subscribers, have the pleasure of exploring a new world of tropical birds, animals, and seashells, as well as the opportunity to gain an insight into some of the problems of rural Central America.

We wholeheartedly support programs to preserve the few remaining undisturbed ecosystems in Central America as national parks and forests, but we hope the readers of *Natural History* will recognize that there is also an important niche for the private recreational land developer in this complex.

ALAN D. HUTCHISON, *President*
Beaches of Nosara

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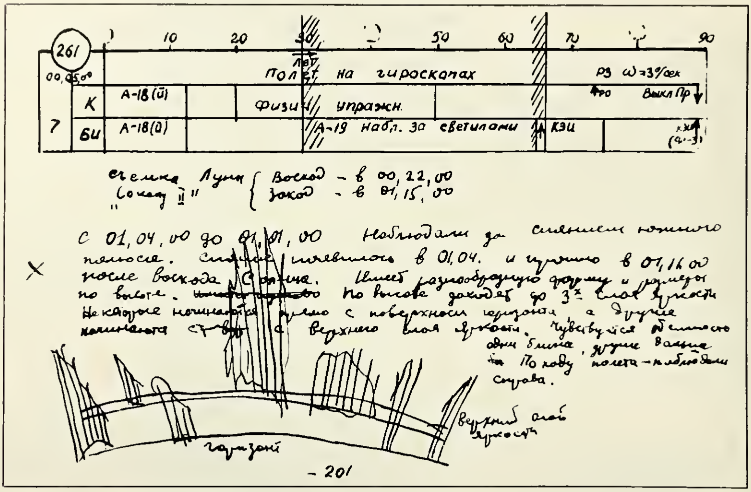
Twilight Seen from Space

During brief moments of dawn and sunset, Russian astronauts obtained a rare—and possibly significant—view of the earth's atmosphere

by K. Ya. Kondratyev and O. I. Smokty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С 01,04,00 до 01,[illegible],00 Наблюдал за сиянием южного полюса. Сияние появилось в 01,04. и пропало в 01,16,00 после восхода Солнца. Имеет разнообразную форму и размеры по высоте. ~~[illegible]~~ По высоте доходит до 3^х^ слоя яркости. Некоторые начинаются прямо с поверхности горизонта, а другие начинаются ~~[illegible]~~ с верхнего слоя яркости. Чувствуется объемность одни ближе, другие дальше по ходу полета — наблюдал справа.

The flight log kept by A. G. Nikolayev on the Soyuz IX *mission in 1970 describes the glowing of the nocturnal horizon seen near the South Pole on the spacecraft's 261st orbit.*

The atmosphere is an encircling ocean of air several miles high, which shields and supports life on the earth. It protects our planet from the extreme cold of the universe while conserving the warmth radiated by the sun. It filters out life-destroying cosmic rays from distant space and lethal ultraviolet rays from the sun while transmitting the beneficial solar energy essential for the continued existence of plants and animals.

Because the atmosphere is crucial to life, its composition and quality are of surpassing importance. Man, as an earthbound creature, could formerly observe the atmosphere only from below. Instruments, sent aloft to measure atmospheric gases and particulate matter and take photographs under different light conditions, could not describe the full panorama to be seen from the upper atmosphere or report on unexpected phenomena. That had to await the manned orbital flights that began on April 12, 1961, when man for the first time observed the earth and its atmosphere from above.

Yuri Gagarin, like all the astronauts who followed him, was struck by the unfolding view. "What beauty," he exclaimed when he saw the earth's changeable gamut of colors. On his return, Gagarin described his impressions: "I saw clouds and their light shadows on the distant dear earth. . . . The water surface looked like darkish, slightly gleaming spots. . . . When I watched the horizon, I saw the abrupt, contrasting transition from the earth's light-colored surface to the absolutely black sky. I enjoyed the rich color spectrum of the earth. It is surrounded by a light blue aureole that gradually darkens, becomes turquoise, dark blue, violet, and finally coal black."

Since Gagarin's historic flight, all the Soviet and American astronauts have made visual observations of the earth and its atmosphere for scientific rather than esthetic purposes. The potential of visual observations made from manned spacecraft arises from the fact that the human eye is a marvelous optical instrument. It can determine the brightness and color of various surfaces, detect objects, observe such atmospheric phenomena as thunderstorms and cyclones, determine the brightness of the stars, the moon and the planets, and monitor the motion of clouds. Experience has shown that human observation is also a powerful means for investigating the processes taking place in the upper atmospheric layers.

During the orbital flights of the manned *Soyuz* series, which began in 1967, continuous, systematic visual investigation of specific areas of the atmosphere for periods of from one to eighteen days was undertaken. The earth's nocturnal, dawn, daytime, and sunset horizons

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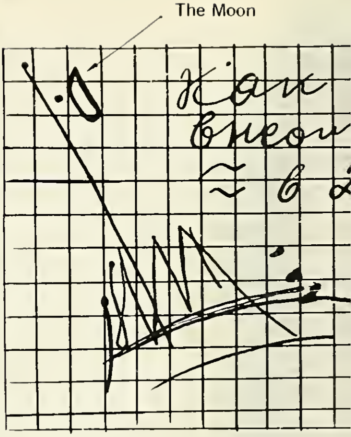
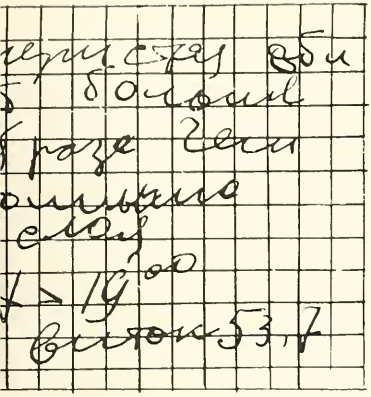


were studied with particular attention given to the atmosphere in the transition zones from night to day and day to night. In the conditions of space twilight, the atmosphere acts like a gigantic prism, breaking up the incoming solar radiation into a spectrum of component colors. More atmospheric structure and color gradation can be seen in space than on earth, and it was in these transitional twilight zones that the astronauts observed phenomena that widened our knowledge of the processes that occur where the upper atmosphere and solar radiation interact.

When the *Soyuz V* spacecraft was in the earth's shadow, a homogeneously luminous layer, or corona, of ash gray color and constant thickness was observed over the nocturnal horizon. The slightly washed-out upper boundary of the layer could be easily discriminated against the black background of outer space. Near the earth's horizon and at the upper boundary of the luminous ash gray layer the effect of increased brightness was observed in the form of narrow light strips. The middle part of this layer decreased in visible brightness but remained constant in the vertical direction up to the above-mentioned light strips. The luminous corona had barely noticeable discrete layers in which it was sometimes possible to distinguish several threadlike strips of different brightness and color tones. The layered structure of the luminous corona on the nocturnal side of the earth was also observed during the flights


19°°
Виток 53,7

A page from the log of astronaut G.T. Beregovoy on the Soyuz III *flight in 1968 shows his version of the vertical raylike structure observed at dawn and sunset.*

of both *Soyuz VIII* and *Soyuz IX.*

A stable correlation was noted between the structure of the nocturnal luminous layer and the illumination conditions of the atmosphere at sunrise. In the vicinity of the subsolar point the corona gradually becomes thicker, "ragged," and washed out. In this area a haze just above the nocturnal luminous layer begins to glimmer up to heights approximately twice the height of the corona over the horizon. When the angle of the sun below the horizon reaches a critical value, the luminous corona in the area of the subsolar point disappears; simultaneously, the phenomenon of space dawn with its characteristic gamut of colors appears.

The nocturnal luminous layer remains at the right and left of the rising sun, but parts of the corona in the immediate vicinity of the luminous layer become ragged and acquire a vertical, raylike structure in the form of thin luminous threads that stretch upward from the light strip near the horizon to a height approximately twice that of the luminous corona. The astronauts made drawings of this structure in

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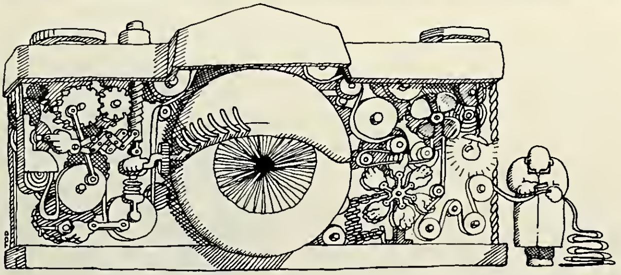

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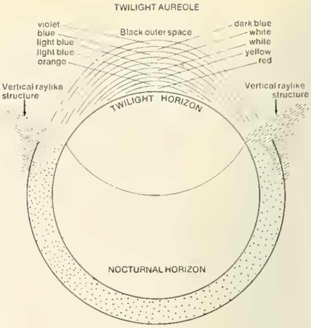

A diagram of the earth's complete horizon illustrates the atmospheric radiation observed at different times by the astronauts. The nocturnal horizon, shown at the bottom, was seen primarily as a luminous gray layer. The twilight horizon of dawn and sunset, shown at the top, contained vertical layers of different colors. To the right and left of the twilight aureole are the luminous threads, called vertical raylike structures, first detected by the astronauts.

their flight logs and calculated that the height of the threadlike radiation was two to three times that of the nocturnal layer. This splitting of the nocturnal luminous corona, which had not been known before, was observed from *Soyuz IX* immediately before sunrise.

One of the most impressive sights seen from space is the earth's atmosphere near the dawn horizon. When a spacecraft is in the shadow zone and approaches the terminator line dividing the dark from the lighted regions of the earth, a crescent-shaped area colored differently at different heights is observed in the direction of the dawn horizon. Although the astronauts' descriptions of this phenomenon differed from flight to flight, all were impressed by the variety and quick change of colors at space dawn.

The cost of this advertisement is borne by Eastman Kodak Company

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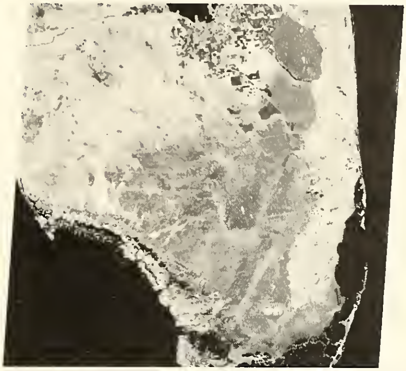
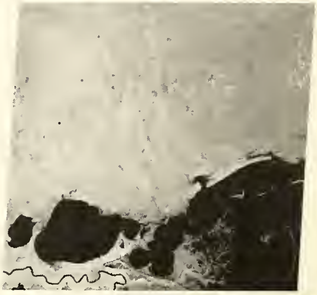
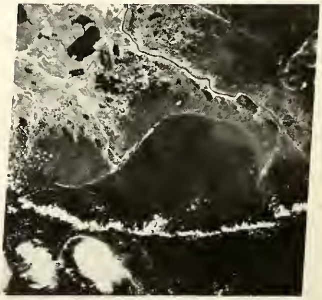


Miami and environs, 22 March 1973

New Orleans and environs, 7 August 1972





Mississippi delta, 7 August 1972

The U.S. Geological Survey, which runs the EROS program (Earth Resources Observation Systems), points out an opportunity to serve the public interest by calling to your attention that imagery is now available of just about any region on earth, except within some 900 miles of the poles.

Everywhere else, NASA's ERTS (Earth Resources Technology Satellite) goes over every 18 days 567 miles high, looking down in four wavelength bands: 0.5-0.6 μm, 0.6-0.7 μm, 0.7-0.8 μm, and 0.8-1.1 μm. Anybody–grade school teacher, ranch broker, botanist, Cub Scout–with \$1.75 to spend can have a 9″ x 9″ print of any place selected. The 9″ x 9″ will encompass 115 miles x 115 miles. Changes may be apparent from the previous pass.

For the sake of preserving the earth's glory, let's learn how to look through mankind's new microscope-in-reverse. Let's assume that if Aristotle and his friends had had even ordinary microscopes, we'd all be happier today.

Details:

San Francisco and environs, 4 April 1973

A quick way to get a look through that great new reverse-microscope in the sky is to phone 605-594-6511 between 7 a.m. and 7 p.m. Central Time. Tell what geographical area interests you and what you have in mind. You will be talking to a helpful, well-informed, and quite real person. His or her hand that isn't holding the telephone will be in contact with heavy computer power.

The computer will even know how much was under cloud each time ERTS passed over the region of interest. It might even report that the area was photographed in 1936 and that, if you'd rather have that black-and-white shot from 5,000 feet instead of infrared "false color" from 567 miles, you can so order. Or you might be told the same place was photographed by a Gemini astronaut with a hand-held camera or by completely automatic equipment from Skylab this year, and how would you like *that?*

The EROS price list reflects just the cost of reproducing the photographs. (The cost of the satellite is more widely shared.) A 40″ x 40″ color enlargement on paper, for example, is priced at \$25. To avoid misunderstanding, you can take down the numbers of possibly interesting pictures and check them out on a microfilm browse reader at any of 19 locations in the U.S.A. before placing your order. Black-and-white copy negatives or color internegatives can be ordered if you wish to do your own printing. No copyright worries.

If you want to experiment with the color rendition of the bands to emphasize certain signatures, come in person any business day from 7:45 a.m. to 4:30 p.m. to EROS Data Center, 14 miles northeast of Sioux Falls, S.D. Scientific staff members are available there for consultation on instrumentation and interpretation problems.

Don't expect much, though, by way of direct interpretation. *That* the customer does, or consultants the customer may engage, assisted by a fast-growing literature. Aerial photography and the interpretation thereof are not leaving the private sector. On the contrary, those in the business welcome EROS as a tantalizer to swarms of new prospects.

EROS Data Center can also be queried by mail (ZIP 57198).

An article in *American Scientist 61*:175 can take you farther into this fascinating subject. Address reprint requests to Eastman Kodak Company, Dept. 55W, Rochester, N.Y. 14650. But get in touch with EROS, not Kodak, if you want a picture of the old home town from 567 miles up.

You have heard of self-fulfilling prophecy? Its converse, self-denying promise, may threaten if this advertising proves too successful. There must be a limit to how many inquiries a day can be handled in the manner promised here.

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Air Afrique's fleet now features DC-10's clean-powered by General Electric jet engines.

According to visual observations made from *Soyuz IV* and *Soyuz V*, the earth's edge under these conditions is seen as a distinct black line. Above that the dawn aureole is red orange, which gradually turns into yellow orange, then yellow, then a narrow strip of dark blue of low brightness at a height approximately one-third the vertical size of the aureole. The dark blue strip is followed by an area of medium blue tones, which blends into light blue tones with a whitish tint. That area, occupying approximately two-thirds of the aureole height, changes in turn into black violet tones, which merge into the blackness of open space.

The angular height of the dawn aureole is at its maximum immediately before the sun rises above the horizon. When the first solar rays appear, the aureole's height shrinks abruptly by approximately one-third, its brightness intensifies, and the dark blue strip disappears. Simultaneously, the saturation of the color tones of the dawn aureole increases.

If the sky is overcast, the lower part of the dawn aureole is seen as purple red instead of red orange. The spectrum of colors in the aureole is otherwise the same as in a cloudless atmosphere, but the upper edge of the cloud layer appears washed out and slightly phosphorescent. Rifts in the cloud layer are deep dark red tones.

When the sun has risen, but the spacecraft remains above the shadowy area of the earth behind the terminator line, the central part of the zone of solar illumination, earlier occupied by the aureole, loses its color. The sun shines against the dark background of space; at its right and left, in the direction of the terminator, a whiskery glow is observed. This occurs when the solar height above the horizon is 6° to 15°. In the terminator region itself the colored aureole separates from the earth's surface and moves off tangentially toward the zone of black starry sky to a height of approximately 155 to 185 miles. It is in association with these tangents that the symmetrically located glowing areas, or "whiskers," are observed with a vertical gamut of colors similar to that of the developed dawn horizon. The spectrum of dawn remains the same, but the

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Not an inexpensive knife.

I am told by my friends who pride their cooking, that this is just that—a remarkable knife that brings a new celebration to cooking. Its balance is such, its blade so acute, that with a small flick, you can pare fat from the shank of meat.

That, some remember, is exactly how gourmet great, Dione Lucas, came to create this remarkable knife.

Her recipe for Supreme de Volaille called for carefully removing all the fat from the tender meat.

A trace of fat would cause the sauce supreme to spot. "You have ruined my Volaille," she said. For no knife satisfied her with its truth of edge.

It is completely within the bounds of safety to say that once you own the Dione Lucas Gourmet Knife, you may never again have to purchase a knife for your kitchen.

In fact, that is the way we guarantee these remarkable knives. Should you ever need a replacement for any reason, simply return the knife, and a new knife will be sent to you, at no cost to you.

How can such confidence be placed in what would appear to be a simple knife?

A most special steel of molybdenum mix is used in the manufacture of the blade. This blade keeps its edge for life with simple honing.

Then there is the balance I spoke of. When you lift the knife, you will note it is lighter than an ordinary knife. This is because the knife is so perfectly balanced, that it does not need added weight to help it cut! This balance, in your hand, makes possible an accuracy of cut you have never before known. A certainty of cut quite unique in any cooking experience you may have had.

I make no pretense of low price for this knife. It is not, by any means, the world's most inexpensive knife set. Yet when you consider it as a lifetime investment, its value takes real meaning.

A set of 4 of these knives is $14.98.

Were it to be sold for less, the very qualities that make this knife so supreme, would have to be lessened.

And these knives have been subjected to extreme tests to assure their quality.

A one pound ball has been dropped on this from 6 feet to test the strength of the Rosewood handle.

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Because this is such a unique ownership, I am including with each set of these knives, four recipes of Cordon Bleu teacher, Dione Lucas, where the use of her knives is quite critical to the outcome of the recipe. (Including her recipe for Supreme de Volaille.)

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distribution of colors changes. At sunrise the blue violet part at the top of the spectrum narrows. When the terminator line is crossed, the colored whiskers disappear completely.

When a spacecraft moves from the dark to the illuminated side of the earth, the line of the daytime horizon is seen as washed out by a veil of haze that contains no noticeable vertical raylike structures. Although the daytime horizon line is not sharply defined, its curvature is clear. The color of the daytime haze is dependent on the height of the sun and the presence of clouds. Thus, over ocean, a cloudy atmosphere near the horizon is a dirty grayish color, whereas a cloudless atmosphere is bright blue. The haze color changes vertically from either bright blue or dirty gray to dark blue, which merges above the atmosphere into the blackness of outer space. When the sun is high, stars are not usually visible in its direction, but can be seen through the antisolar spacecraft window—180° opposite the sun—at solar heights of less than 15° to 20° over the horizon. The conditions of star observation are apparently determined by the influence of solar light scattered by elements of the spacecraft structure. The moon is seen against the dark blue strip of the earth's horizon and the black background of space as a brown sphere with light spots. The brightness of haze near the earth's horizon does not diminish the visible brightness of the moon.

From the height of the spacecraft orbit, about 125 to 155 miles, on the daytime side of the earth, surface landmarks such as lakes, rivers, forests, mountains, cities, and villages can be clearly seen. Snow on the mountains, aircraft vapor trails, and cloud shadows on the earth's surface can also be distinguished. All kinds of cloud formations, storm systems, and the horizontal and vertical motion of cloud layers relative to each other are noticeable.

Atmospheric transparency varies over different geographical regions of the earth. Observations from *Soyuz IV* and *Soyuz V* showed that the purest atmosphere in the zone from 52° north latitude to 52° south latitude was over the Pacific Ocean in the region of the Kuril Is-

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The Early American Society, founded in 1969, is dedicated to bringing the total story of American social history of the period, 1700-1850, to those who wish to use it in their lives. We accomplish this through several programs including publishing EARLY AMERICAN LIFE six times each year. Our magazine features articles, lavishly illustrated, on arts, crafts, antiques, restoration, travel to historic sites, and all related subjects of interest to members.

To foster reading of books on these subjects, the Early American Society Book Program offers the latest books of leading publishers at discounts up to 25%. Heirloom quality reproductions of outstanding early furniture items are commissioned by the Society and made available only to members in limited editions. Group travel and historical assemblies offer members the opportunity to enrich themselves under the guidance of qualified professionals.

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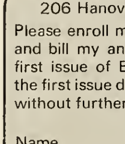

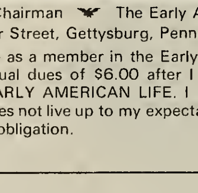

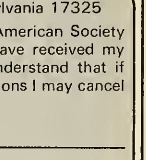

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lands and Kamchatka Peninsula. The atmosphere over continents is more turbid than that over oceans, but the atmosphere over mountains is relatively pure.

Sunset observed from a spacecraft is similar to sunrise. A layered gamut of colors is seen and the colored, vertical raylike structures noted at dawn reappear, but at sunset the height of their yellow red region diminishes. As the sun moves below the horizon and higher and higher atmospheric layers are illuminated by direct solar rays, the illumination of the lower atmospheric layers decreases, and their colors fade.

What causes the rich colors and complicated structure of space twilight? They are determined primarily by the nonhomogeneity and diversity of the optical properties of the earth's atmosphere. Solar light reaching our atmosphere contains radiation of different wavelengths that is either scattered or absorbed at various levels. The blue of the daytime sky, for example, is the result of scattering caused by air molecules in the atmosphere that permit the longer red and yellow rays to pass through while dispersing the shorter blue rays to all parts of the sky.

As already mentioned, our twilight atmosphere acts like a gigantic prism and spreads incoming solar radiation into a spectrum of component colors. The lower, denser atmospheric layers suppress the shortwave radiation in the blue zone of the spectrum and transmit only the long wave radiation of the red zone. Thus, space dawn and sunset near the earth's surface are colored in red orange tones.

At the higher levels of the atmosphere, the density of molecular air decreases, and shortwave radiation begins to scatter effectively. This causes the appearance of blue tones in the upper twilight aureole. In the uppermost atmospheric layers the density of molecular air is so small there is hardly any scattering of solar radiation and the twilight aureole at that altitude is violet black.

At heights of about ten to fifty miles—in the stratosphere—aerosols play an even greater role than molecules in the scattering of solar radiation. Aerosols are systems of minute particles—atmospheric contamination from such sources as

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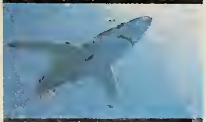
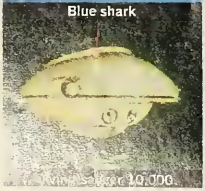

Blue shark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space dust, dust from the earth's surface, volcanic eruptions, forest fires, and industrial pollution. When added in quantity to the atmosphere, aerosols "redden" the twilight aureole in the immediate vicinity of the earth's surface. The volcanic dust from erupting volcanoes spreads in the stratosphere around the world, causing spectacular red sunsets.

Ozone, which is a form of oxygen, also affects the color evolution of the twilight aureole. It is the ozone layer in the stratosphere, about thirty miles above the earth, that absorbs ultraviolet radiation from the sun, thus shielding life from those deadly rays. The color peculiarities of the twilight aureole in the height range of the ozone layer are probably due to absorption of solar light by ozone rather than to scattering by aerosol particles.

Changes in the amounts of aerosols and ozone present in the atmosphere are of serious concern. Aerosols interfere with the earth's ability to absorb solar radiation. They thus influence the temperature. Large-scale modifications in the amounts of aerosols in the atmosphere could therefore affect the local weather and perhaps ultimately the climate. Ozone is necessary for the protection of life. Some scientists believe it could be adversely affected by multitudes of high altitude, supersonic airplanes or other man-made instruments.

Visual colorimetric data on the earth's atmosphere gathered during the long-lasting flights of manned orbital stations like the Soviet *Salyut* and the American *Skylab* can help supply us with a model of the normal distribution of such important atmospheric components as aerosols and ozone. Once there is a model, significant modifications can be monitored.

The observations made so far by the astronauts are a first step in this process, but their data were essentially qualitative. Instruments can now be used to provide quantitative measurements. The purpose of these atmospheric studies is not simply to add to scientific knowledge but, more importantly, to insure that the earth's atmosphere is preserved in a form that will permit the continuation of life on this planet. ☐

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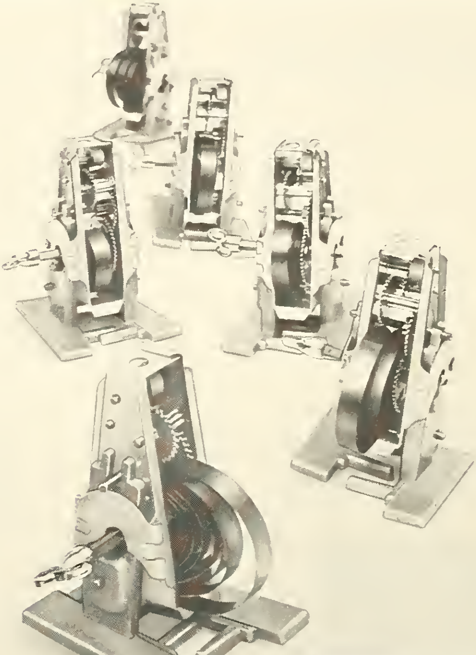

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Turning Plants Off and On

The same chemical that prepares plants for winter dormancy also enables them to germinate when the last frost has passed

Last summer the vegetation outside my windows burgeoned. What with abundant rainfall and high temperatures, plant life thrived, and I had more than the usual job keeping the garden from being completely overgrown. But now the scene outside my window has changed radically. Even before the first frost approached, the plants had anticipated the winter ahead. On the apple and ash trees, leaves stopped growing and turned to brown; on other trees scaly winter buds rather than new leaves had formed at the growing points. Meanwhile, most annuals had produced the seeds in which form they will pass the winter. All these changes, seemingly premature during the warm days of late summer, occurred because a plant's failure to effect them in good time could cause its extinction during a frost. This doesn't mean that the plant knows the date of the first frost and acts accordingly; it means that mid-latitude plants have of necessity evolved appropriate timing mechanisms to insure their survival over periods unfavorable for growth. The key to the mechanism is the changing length of day.

In the northern latitudes, day length reaches its maximum on about June 21 and its minimum six months later. September 23 and March 21 are the equinoxes: times when day and night are of equal length everywhere on earth. At the latitude of my home near New Haven, Connecticut, day length has diminished from its maximum of about fifteen hours to twelve hours by the end of September. It will be reduced to nine hours at Christmas time. Plant leaves take account of this change through the blue pigment phytochrome, which manifests one form during day and another form at night. As the length of day shortens, this pigment exists less and less in its daytime form and more and more in its night form. In the meantime, the plant measures the passage of each 24-hour period through its endogenous circadian, or internal daily, rhythms. But how can the interplay of phytochrome and rhythms in the leaf affect the

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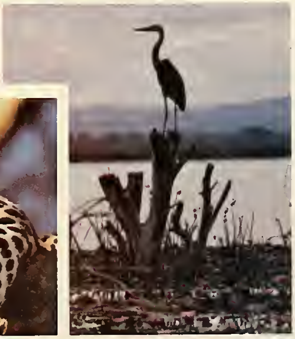

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behavior of the bud at the growing point, perhaps many feet away?

About a decade ago, Prof. Philip Wareing and some of his students at the University College of Wales at Aberystwyth studied the effect of diminishing the daily photoperiod, or light exposure, on the formation of winter buds in the birch tree. They noted that, as the day length shortened, the rate of stem elongation at the apex decreased and eventually ceased altogether. At the same time, the tree stopped making full-sized new leaves; instead, small, scaly leaves began to surround the now dormant bud. They reasoned that some sort of growth inhibitor accumulating at the stem apex might be causing these changes. By making appropriate extracts of the bud as the growing season progressed and testing them on other living plant tissues, the researchers did indeed find an increasing concentration of a substance inhibitory to growth. When purified and applied to plant tissues, this substance not only caused a marked diminution in growth rate but also partially mimicked the effect of short days in promoting winter bud formation. When applied to viable seeds, it created a dormancy, which could be overcome by washing away the applied material. In other words, this inhibitory chemical, produced under the influence of artificially simulated short days, seemed to induce in the plant all the well-known effects of the natural short day itself.

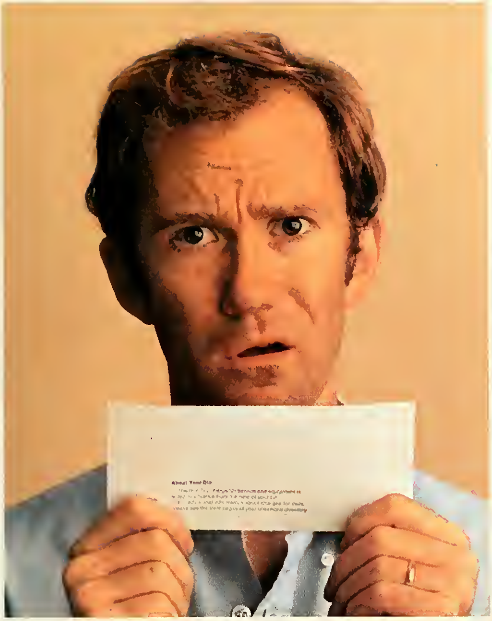
Through cooperation with chemists, Wareing and his colleagues succeeded in isolating pure samples of the effective material. It was then only a matter of time until the chemical nature of its molecule was determined, and this was followed shortly by the development of a purely synthetic method for the production of any desired quantity of the inhibitor. Because the material not only induced the formation of dormant buds but caused seeds to become dormant as well, it was given the common name *dormin.* (Its proper chemical name is much more complicated.)

Scientists are aware that an idea, "ripe" for discovery, is frequently uncovered virtually simultaneously by several different persons working independently of each other. So it was with dormin. At Davis, California, thousands of miles from Aberystwyth, Frederick Addicott and several colleagues were working on the problem of the premature shedding of cotton bolls. This anomaly in certain high-yielding varieties of cotton plants caused them to lose their bolls spontaneously shortly before harvest. Addicott felt that the aberration might be triggered by the movement of a substance from the leaf to the boll stalk. Like Wareing, he made extracts of slightly senescent leaves, applied the substance to test systems, and succeeded in purifying, isolating, and identifying the effective material. Because it caused shedding, or abscission, he called it *abscisin.*

Wareing and Addicott published their results separately, and to their common surprise, they learned they had isolated the same chemical material. Because Addicott's report was published one week before Wareing's, the compound, which is actually an organic acid, was ultimately named *abscisic acid.* ABA, as it is known to botanists, has become an important substance for the plant physiologist and the agriculturist, as it seems to have remarkably versatile effects on many aspects of plant development. Not only does it slow down the over-all rate of growth and predispose the growing points toward a dormant state, it probably plays an important role in the regulatory physiology of plants.

Each day, for example, plants absorb from the soil a large quantity of water, which moves upward through conducting tubes of the woody xylem to the leaves. In the course of its upward movement, the absorbed water facilitates the transport of minerals through the plant. Some of it is retained by root and stem cells and is used for growth and other processes. A small amount of the water that reaches the leaves is used in photosynthesis. But more than 90 percent of the absorbed water evaporates from the leaves through transpiration, a process that probably cools leaves that might otherwise overheat in the direct sun. If transpiration proceeds too vigorously, the plant may lose more water than it is able to absorb. If the resulting water deficit then becomes too severe, the plant may wilt, desiccate, or even die. Clearly, desiccation due to excessive loss of

Wrong number?



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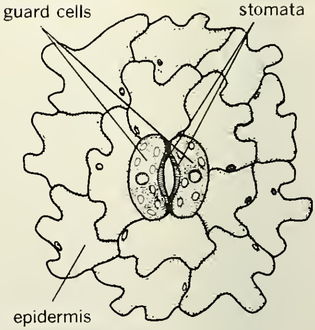
water is one of the most serious problems a plant has to face. Can this dangerous process be controlled, or is high transpiration an inevitable consequence of the architecture of the leaf?

The interior cells of a leaf form a loose, spongy mass of wet surfaces exposed to open channels leading to the outside air. Such a system poses no barrier to evaporation. But at the epidermis of the leaf, the way to the outside world is barred by pores called *stomata,* elliptical openings that change in size as the guard cells surrounding them change in volume. When the guard cells are turgid with water, the openings are large, but when the guard cells lose water and become flaccid, the openings shrink and may disappear entirely, thereby sealing the leaf against further water loss. Whether a guard cell absorbs or loses water depends on its internal salt concentration, and most particularly on the content of potassium salts in its vacuole, a liquid-filled cavity.



Lens-shaped pores, or stomata, in the epidermis of a leaf play a crucial part in plant transpiration. When open, they permit the evaporation of water; when closed, they seal the leaf against water loss. The stomata are, in turn, regulated by guard cells that respond to abscisic acid, the substance that also prepares plants for winter dormancy.

Experimenters at Wye College in England recently analyzed both turgid and wilted leaves for their abscisic acid content. They found that wilted leaves with closed stomata—a protection against further water loss—had consistently high levels of

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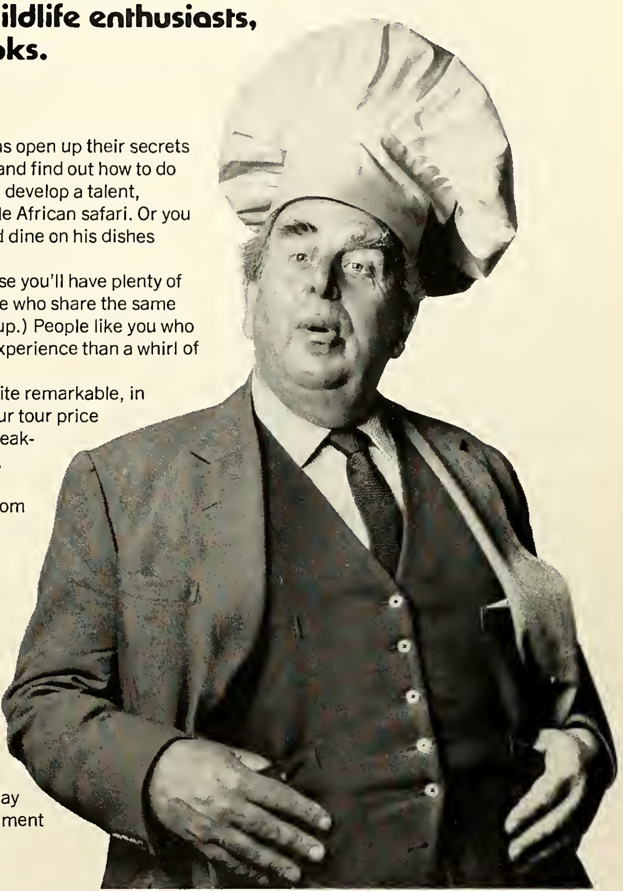

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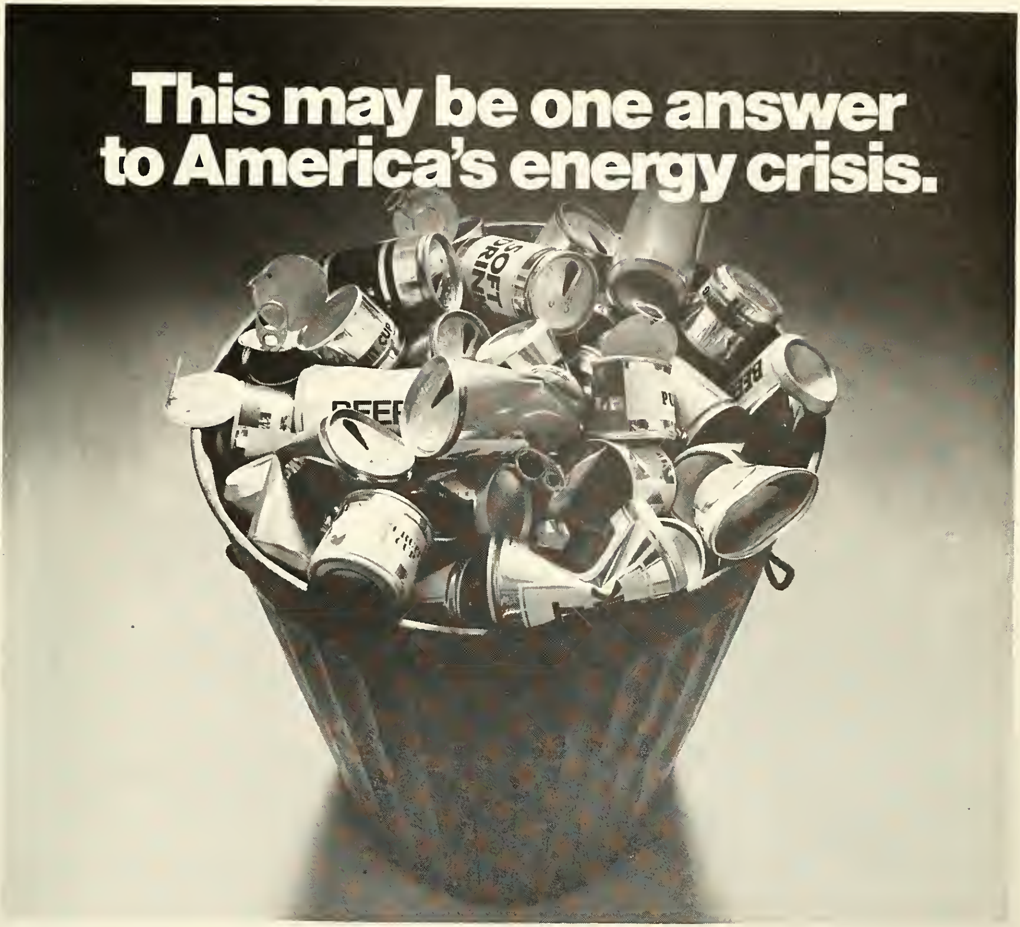
ABA, often ten to twenty times the normal concentration. When ABA was applied to a normal leaf with open stomata, the stomata closed as if the leaf were wilted. This closure was brought about through loss of potassium and, thus, water from the guard cells. The wilting-induced increase in concentration of ABA therefore prevents additional water loss from a partly desiccated leaf and could save the plant's life.

This dehydrating effect of abscisic acid may also help explain another extremely puzzling aspect of a plant's preparation for dormancy. Normal plant cells contain about 90 percent water, while seeds tend to have about 10 to 20 percent. How can a seed be dried out while still attached to the wetter mother plant? It appears that ABA may again be involved. The movement of large quantities of ABA into the seed causes it to lose water to surrounding tissues, even though the over-all water content there may be greater. The desiccated seed remains dormant over the winter and does not start to germinate until the level of ABA declines. In fact, the amount of ABA initially incorporated into the seed and the rate at which this quantity declines over the winter may constitute the chemical timekeeping device that tells the seed that the last frost day has passed and it is safe to germinate. The dormant winter buds of trees and shrubs may use the same device. Thus, ABA may be considered the "turn off" switch that converts an active plant into a dormant one. This is a handy, indeed necessary, survival device in the mid-latitude zone.

The ability of ABA to close stomata and thereby protect plants against excessive water loss can perhaps be turned to practical agricultural advantage in arid zones. The problem will be to effect closure of the stomata without simultaneously overheating the plant or converting actively growing buds to the dormant state. A solution to this problem could have great importance for a world faced with food shortages, especially in those countries that must try to grow crops more efficiently in suboptimal environments.

Columnist Arthur W. Galston teaches biology at Yale University.



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> ***—Diary of a Texas cattle drive, 1866. Quoted in* The Cowboys**

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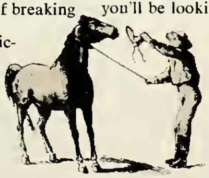

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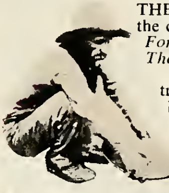
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Detail from "The Cowboy" by Frederic Remington, courtesy Amon Carter Museum, Fort Worth, Texas

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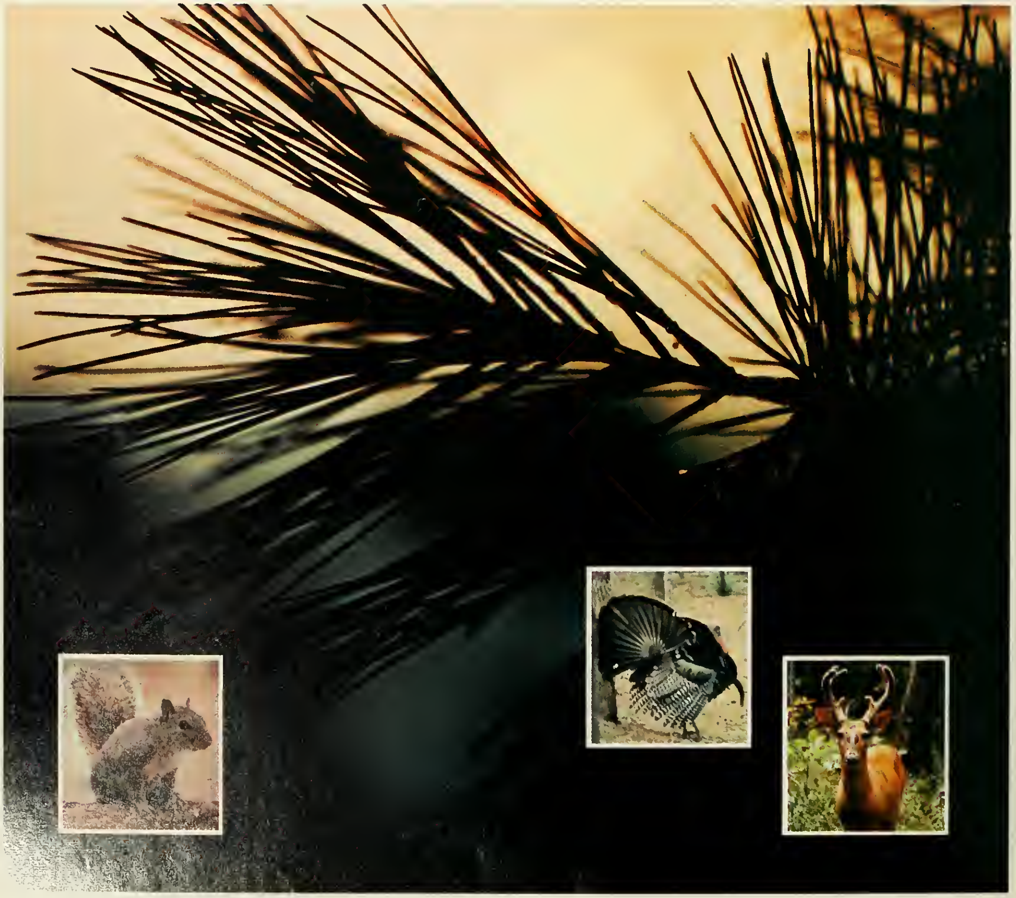
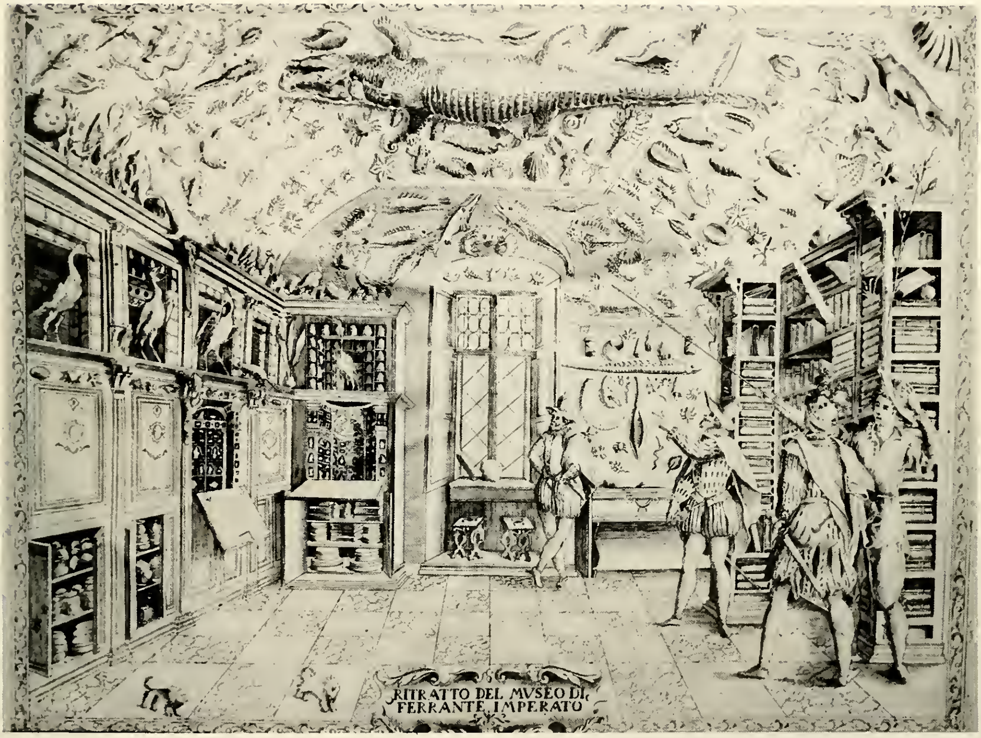
It's good to be concerned about wildlife and the environment. It's also good to know the truth. And the truth is that in the well-managed forest wildlife can thrive and multiply. For more information, write to: Southern Forest Products Association, P. O. Box 52468, New Orleans, Louisiana 70152.



Cabinets of Curiosities

Early natural history museums, featuring such items as mermaids' teeth and dodo remains, were random collections of exotica


RITRATTO DEL MVSEO DI FERRANTE IMPERATO

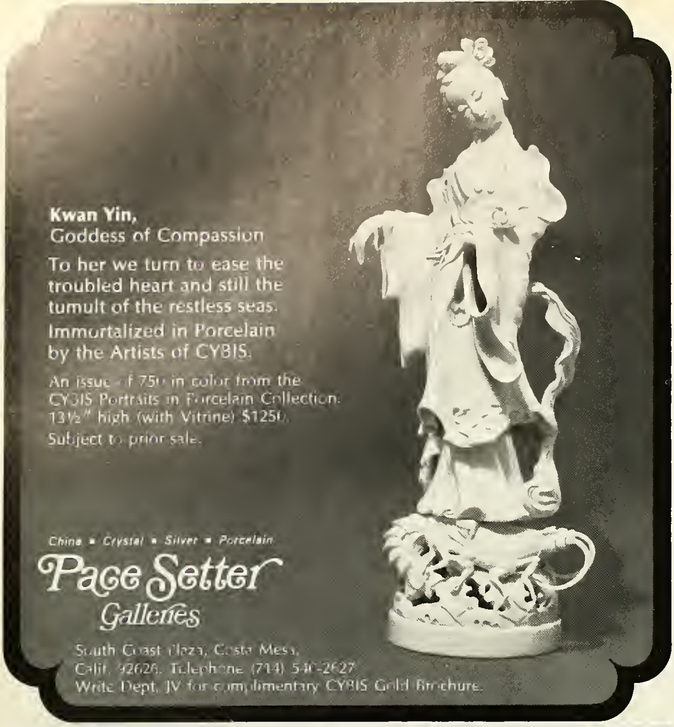
FRANK J. ANDERSON

When Hanno of Carthage hung three gorilla skins in the temple of Tanith he probably created the first natural history exhibit in recorded history. The event took place in about 490 B.C. after a successful voyage of exploration along the west coast of Africa, and the skins remained on view until the total destruction of Carthage almost three and a half centuries later.

Elsewhere in the ancient world live specimens and menageries were common, but they were only used as entertainment. Alexander the Great ordered his generals and governors to send Aristotle zoological specimens from all of the known world, but these were for research, not for exhibition and education. Much the same can be said of the activities at the Museum of Alexandria. There, a relatively small group of scholars, working more in the exact than in the natural sciences, never spread their knowledge beyond their community.

Until the revival of learning in Europe during the early Renaissance, collectors were concerned with paintings, sculpture, and other objects of artistic or high intrinsic value. One of the first collectors to gather natural materials was Augustus I, Elector of Saxony. He formed a chamber of art and natural curiosities at Dresden in 1560, thereby shaping the nucleus of that city's splendid group of museums. One of his greatest treasures was an alleged unicorn horn, which was suspended from the ceiling by a golden chain. But since a famous mineralogist, Georg Agricola, was the guiding spirit behind Augustus's enterprise, useful mineral specimens were also on view.

Other northern princes also had their *Kunst und Naturalien Kammern* to boast of, and they vied with each other in accumulating hetero-



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geneous masses of valuable works and strange or exotic natural products. Probably the most successful of these princes was Rudolph II, emperor of the Holy Roman Empire, who amassed the largest collection of his day. From his accession in 1576 to his death in 1612 he devoted more of his time to increasing his treasure trove in his castle at Prague than to governing his dominions.

Rudolph possessed a large menagerie, including, it is said, a live dodo. According to records, one of his household artists, Georg Hoefnagle, painted a picture of the bird; portions of a dodo's head, presumably from Rudolph's original hoard, were found in the Prague Museum in 1850. Rudolph was given to strolling in his gardens and palace corridors in the company of a pet lion, leaving a trail of nervous courtiers and servants in his wake.

But the Kunst Kammer, housed in the Belvedere at Hradcany, was Rudolph's special pride and joy. There he cut and polished gemstones, painted pictures, and observed the stars with the Danish astronomer Tycho Brahe. Surrounding him was one of the largest mixtures of masterpieces and trash the world has ever known. Holbein, Dürer, and Titian shared rooms crammed with cases that held such unlikely items as a phoenix feather, nails from Noah's Ark, and a set of mermaid's teeth! When the enormous pile was distributed as booty at the end of the Thirty Years War, it provided enough material to furnish museums in Stockholm and Vienna, as well as several smaller cities in Germany.

The all-inclusive, or pack rat, style of collection stayed in favor for a long time. Michael Bernhard Valentini's *Museum museorum,* which was published between 1704 and 1714, lists some 161 museums established by royalty, municipalities, or interested individuals. These were scattered over the globe in such diverse places as Cuzco, Vienna, Copenhagen, Constantinople, Rome, Agra, and just about everywhere in between. Not all were still in existence by Valentini's time, but he sought as much documentation of their former holdings as he could find.

One curious by-product of his in-

Continued on page 104

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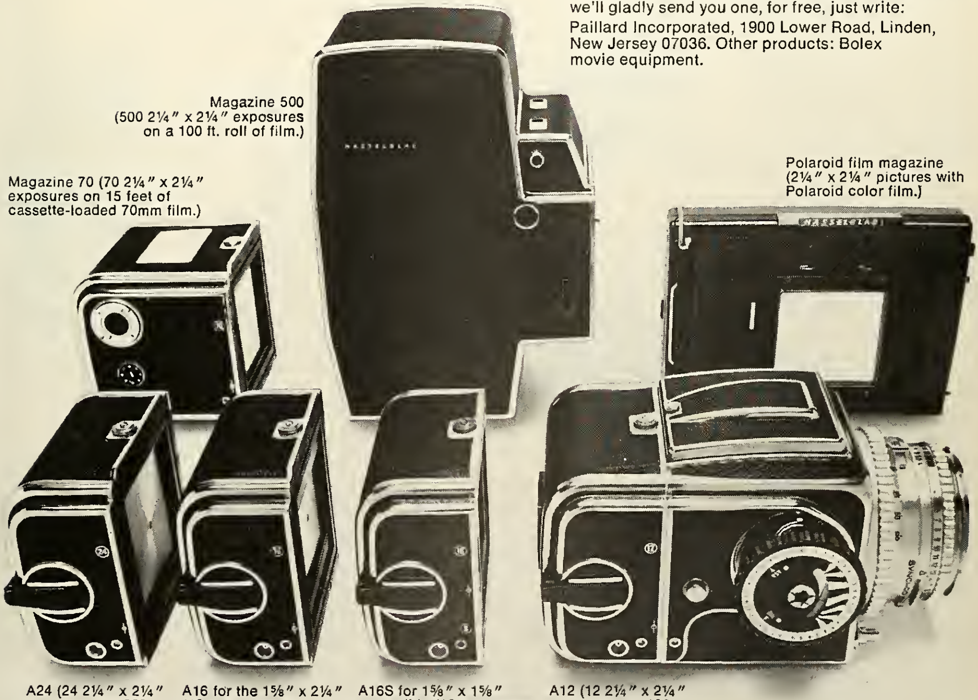

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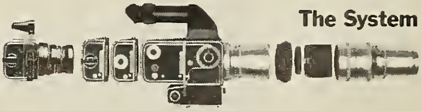

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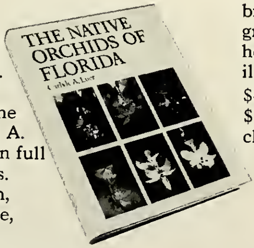

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The Metro Forest

A Natural History Special Supplement November, 1973

Prologue

After the last glacier retreated on North America some 11,000 years ago, a giant green carpet of trees crept northward, covering the continent from the Atlantic to the edge of the Plains.

When the first European settlers arrived, only three centuries ago, they launched a struggle against the primeval forest: girdling and burning, cutting and consuming, tearing out and overturning. It was an unequal contest; man destroyed the forest in waves rolling from east to west. By the beginning of this century The Great American Forest had been reduced to a remnant of its former majesty.

In the twentieth century, man rapidly became urbanized, abandoning rural areas and agriculture in many regions. The irrepressible forest has gradually returned, taking over the abandoned fields, encircling the dying villages of Appalachia, rising above the houses of older neighborhoods, even approaching stages of its former glory in parks, cemeteries, woodlots, and undisturbed watersheds.

The rise of The Metro Forest in America heralds a new relationship between man and trees. The types of dominant trees may be changing; certainly the distribution of wildlife is different. And people are developing a new ethic toward trees, as they perceive the physical and — possibly most important — the spiritual value of the forest in the life of modern man.

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The Natural History of Urban Trees

by Ervin H. Zube

Trees have been around for about 300 million years. Cities are thought to have started about seven to eight thousand years ago. Trees and cities, however, do not appear to have been brought together by the conscious act of design until roughly two hundred years ago.

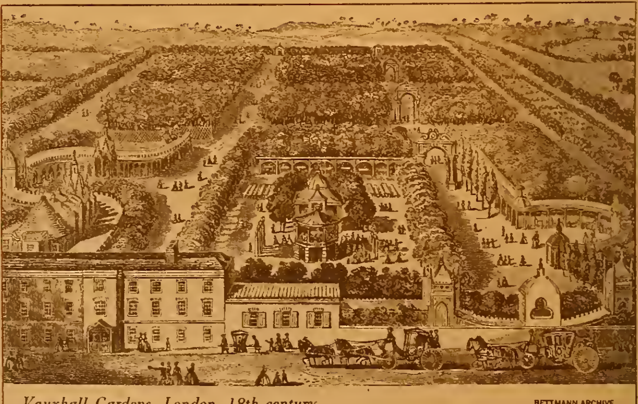
The history of urban design contains very few references to the presence or the use of trees in a public sense. There is evidence that in ancient Egypt trees were used in private gardens to provide a more salubrious environment for the wealthy or the ruling class as early as 2800–2100 B.C. But no evidence has been uncovered of the use of trees as a part of the public landscape of the city. The example of Egypt holds true through the Middle Ages and the Renaissance. The medieval city, enclosed by defensive walls, did not contain trees. The open spaces of the city were architectonic, and the only view of trees or woodlands was through an open town gate or over the walls to the landscape beyond.

Conditions changed dramatically in the eighteenth century, the impetus emanating from the seventeenth-century baroque gardens of France, which were laid out in formal geometric patterns with long axes, suggesting by their form and grand scale that man had surely mastered nature. These large gardens were designed with long, straight roadways cut through the forest. Usually radiating from several central points, the roadways provided an ideal situation for the owner while hunting: while his beaters worked their way through the woods, he was afforded a clear field of fire down each of the roadways. Thus, it was possible to go to the hunt without any discomfort.

These tree-lined roads, or pathways, which were so much a part of French gardens, strongly influenced eighteenth-century town design. They provided the pattern for what was envisioned as the ideal street layout. Washington, D.C., designed in 1791 by Maj. Pierre Charles L'Enfant, is a case in point: streets are laid out with as much concern for the field of view as for any more utilitarian, or functional, concern. The spaces and streets in both French gardens and in nineteenth-century cities such as Nancy or Bath or sections of Paris were sharply delineated either by the forest or by the planting of trees along the edges. The epitome of French garden design of the time, and undoubtedly the strongest influence on city design, was Versailles, designed between 1661 and 1674 by André Le Nôtre for Louis XIV.

Shortly thereafter trees began appearing in the London landscape. According to the architectural historian Sigfried Giedion, "Around 1800 [the] open spaces in the middle of the London squares were laid out with freely planted trees and lawns, the beginning of that luxuriant greenery which natural growth brought in due course of time." The image of the London squares (there were about fifteen of them by the mid-nineteenth century) was thus one of trees and grass. These were residential squares—that is, they were surrounded by housing, not by shops and markets. Some still exist today and exude the image of quiet, substantial, and comfortable residential neighborhoods. It has been suggested that the "adulation of nature" was so strong in England at this time that people felt almost a moral obligation to plant every open area.

It was during the eighteenth century that the English romantic landscape movement reached its peak. The influence of the rigid geometry of the French gardens gave way to free-flowing lines and gently curving contours. The boundaries between garden and countryside disappeared, and the landscape image that we now call "parklike" became dominant.



Vauxhall Gardens, London, 18th century

BETTMANN ARCHIVE

Wide, tree-lined boulevards were cut through Paris under the influence of Baron Georges Eugène Haussmann in the 1850s and 60s, but they were not residentially oriented. In Haussmann's words, the tree-lined boulevards were "to disencumber the larger buildings, palaces, and barracks in such a way as to make them more pleasing to the eye, afford easier access on days of celebration, and a simplified defense on days of riot." Also according to Haussmann, they were "to assure the public peace by the creation of large boulevards which will permit the circulation of air and light but also troops." Haussmann's concept of boulevards grew out of the radiating paths and roads of the baroque garden. The baroque garden idea, however, "was to have long avenues planted with trees but devoid of houses." Considering the sixty or seventy years of French history previous to Haussmann's time, it is not the least bit surprising to find a frequently stated concern for troops and defense. After all, Haussmann worked for Prince Louis Napoleon—later known as Napoleon III—who came to power after the Revolution of 1848, a revolution that took place in the streets of Paris.

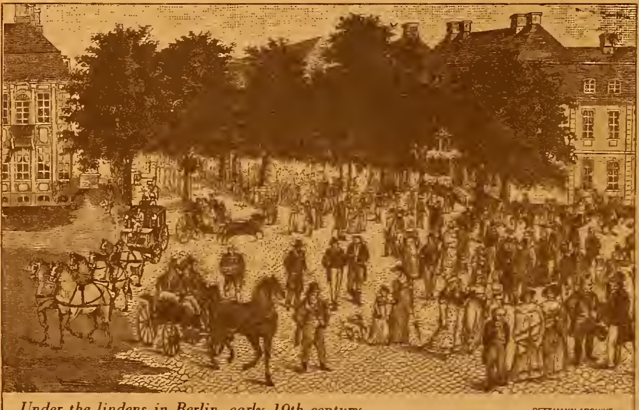
On the American scene, contrary to expectation, trees were not an integral part of New England communities from their inception. During the seventeenth century, the village green was a place for mustering the militia and herding cattle in the event of an Indian attack. Trees undoubtedly would have been discouraged because they could have provided concealment and protection for the attackers. The present popular image of a New England town center—the common of trees and grass—is a very late eighteenth- and early nineteenth-century development.

Philadelphia, a city that had been planned by William Penn in 1682 with five open squares of eight to ten acres each, which were to have only trees, was quite lacking in street trees until the end of the eighteenth century. Insurance companies would not insure houses that had trees in front of them. It wasn't until 1784 that one company—the Second Mutual Fire Insurance Company, later appropriately called "The Green Tree Company"—started accepting such clients.

An act passed in 1807 in the territory of Michigan, dealing with Detroit, called for a double line of trees on both sides of 120-foot avenues and for trees to be planted in "clumps or groves . . . of an elliptical shape" on both sides of 200-foot avenues. This act also provided for residential squares, probably similar in concept to those of London, that were to be "planted with trees or otherwise improved and ornamented."

At least a partial understanding of the changing values placed upon trees and open space in the design of some American cities in the early nineteenth century can be gleaned from the report of the commission that was appointed to select the site for the permanent capital of Mississippi in 1821. The report reads: "And even in a small town there would be a comfort, convenience and greater security against fire, as well as a fairer promise of health, all combined, by having every other square unoccupied by anything except the native trees of the forest, or artificial groves." The commissioners were discussing the merits of using a town-planning scheme in which every other block—in checkerboard fashion—would be tree-covered open space.

This conscious inclusion of trees in the design of American cities grew out of the French baroque garden and matured in the English romantic landscape movement. The design concepts of this movement were adopted at the beginning of the present century as models for



Under the lindens in Berlin, early 19th century

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numerous proposed urban beautification programs. Paris, in particular, with its broad, tree-lined boulevards became the model for plans for Chicago, San Francisco, St. Louis, Detroit, Los Angeles, and Minneapolis.

The main components of these "city beautification" plans were landscaped parks, boulevards and parkways, and civic centers. These plans, with their clearly delineated spaces and tree-lined, radiating streets were superimposing a new structure on the gridiron pattern of many American cities.

The physical structure implicit in the plans establishes a set of visual hierarchies in one's perception of the city. The importance of a street or open space is stated by its scale and by the use of trees, usually used in regular, formal patterns, to define its edges. By reading the visual clues provided by the trees and the scale, it is easy to determine which spaces are important.

The English romantic landscape movement was more significant in influencing the form outside of the center city. The movement, which started as a reaction to growing industrialism, had its strongest impact on the design of the new suburbs that sprang up in the late nineteenth century. In England and in the United States, those who could afford to escape the industrial city's concentrations of human suffering did so, and the "natural landscape" assumed a new significance. It became a symbol of all that was good, as exemplified by the writings of Thoreau, in contrast to the city, which was lacking in the qualities of nature.

Suburbs were designed with the intent of capturing the spirit of the natural landscape. Gently curving streets threaded through wooded, rolling hills. Llewellyn Park in Orange, New Jersey, dating from about 1853, was one of the earliest such suburbs. Lake Forest and Riverside, both in Illinois, Roland Park in Baltimore, and Ridley Park in Pennsylvania are other examples from the last half of the nineteenth century. These suburbs were usually developed with large lots on wooded, rolling land. When not wooded, trees were added immediately, and in abundance, to simulate natural woodland. This "natural effect" was an essential ingredient of the romantic landscape. The trees provided a natural blotter that tended to visually absorb the activities and structures of man. They provided a major element of contrast between the city, which at that time was becoming more and more industrialized in image, and its counterpart, the suburb.

The full impact of these designs on suburban development was not really felt, however, until the 1930s when the Federal Housing Administration promoted the use of curvilinear streets. These plans were based on concepts worked out at places like Llewellyn Park and Riverside. But lot sizes were usually smaller, and one other major ingredient was frequently missing in the new designs of the 1930s, 40s, 50s, and even the 60s—the trees. These subdivisions were frequently built in open fields rather than wooded areas and little if any thought was given to the introduction of significant numbers of trees.

The London squares, the report of the commission to select a site for the Mississippi state capital, and the nineteenth-century suburbs that were a product of the attachment to the "romantic ideal," all imply that prestige or amenity value was added to the residential environment by trees. The evidence seems rather conclusive that there is a long association of trees and wooded lots with upper- and middle-class residential values in Western history. During the time of the Roman Empire, the Renaissance, or even late nineteenth-century America, those who could afford it lived on the fringe of the city absorbed by nature—although sometimes the trees were made to conform to man's idea of a more appropriate form by pollarding or topiary work. Go to almost any American metropolis today and seek out the most prestigious residential areas—you will probably find that most are in wooded sections. Names also give an indication: Forest Hills, Woodland, Lake Forest, and a host of others that either explicitly or implicitly equate trees with a quality living environment.

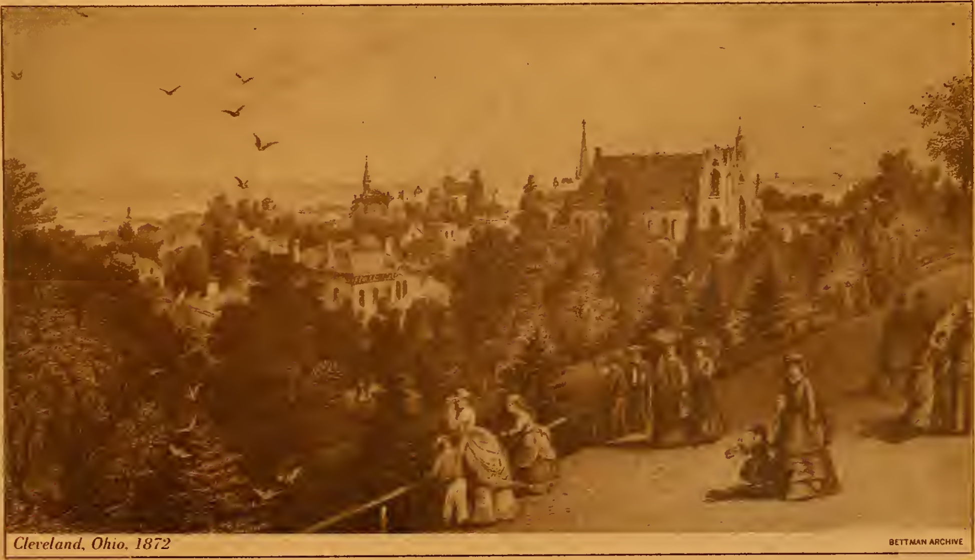
There is no reason to assume that long-held values of the ideal residential environment are going to change. A Louis Harris poll, which included consideration of Americans' desires in reference to lifestyles and environmental values, had 95 percent of those polled listing "green grass and trees around me" as an important environmental value. The romantic landscape movement—born in England, nurtured by the writings of Jefferson and Thoreau, and exemplified in the designs of Andrew Jackson Downing and Frederick Law Olmsted—is still very much a part of the American value system. As Bayard Hooper put it in a *Life* magazine article discussing the Harris poll, "Americans paint an almost Jeffersonian picture of their aspirations: green grass and trees, friendly neighbors, churches, schools and good stores nearby."

Trees can also play an important

role in urban environments where the American ideal has been difficult to achieve. In discussing a Miami slum in 1965, two journalists wrote, "In short, the Groves' Colored Town was a slum ghetto, leaderless and neglected, where living conditions were ameliorated to a modicum of livability only by the historical accident of low population density and the beneficent climate which hid the rotting shacks behind a profusion of trees and flowers."

I am not suggesting that we hide our evils behind a wall of trees, but that we consider the use of trees as a means of environmental amelioration. Many residential streets—not necessarily slums—in many cities are sterile, visually monotonous environments that would be improved by street trees. The trees create a ceiling of branches and leaves over all or part of the street, thereby changing the scale. A pattern is created by the changing shadows cast by the trees and by the sunlight filtered through their branches onto the street and sidewalk. These human-scale considerations, when combined with the seasonal characteristics of trees, provide a changing visual environment. Some change or environmental diversity is important to all of us.

Landscape critic J.B. Jackson in an article in *Landscape* magazine provides us with a concluding summary of the well-designed city. He envisions such a city as "one where we everywhere feel at home; it reminds us, everywhere and at all times, that we are in an environment no less natural, no less stimulating than the environment of the country dweller. Its trees and parks and lawns are more than agents of health; they tell us of the passage of the seasons, and its open places tell us the time of day. . . . If it cannot provide us with the sounds of the remoter landscape, it at least provides us with areas where the sound of human voices and footsteps are not drowned out by mechanical noises, it provides us with quiet. It cannot imitate all of nature, but it gives us archways and pools of daylight, and flights of steps and views; the splash of water in fountains, echoes and music; the breath of damp cool air, the harmony of colors and the unpolluted sun; indeed it gives us so much that our excursions into the countryside cease to be headlong flights from a sterile environment and become a conscious searching for the missing ingredients: solitude in the presence of other forms of life, space and mystery." ☐



Cleveland, Ohio, 1872

BETTMAN ARCHIVE

City Forests of Europe

by Clark E. Holscher

The birthplace of modern forestry is central Europe, where because of the high population, tremendous amounts of wood for building and fuel have been consumed since man first settled in the region. Until railroads came into existence in the last century, each settlement had to satisfy its own needs for wood from the forests in the immediate vicinity. These communities were forced to discover and apply forest management in order to secure perpetual harvests from the adjacent forests.

Consequently, most of the forests in Europe today are owned by communities. In Switzerland, for instance, some 70 percent of the forests are community owned, 5 percent are state forests, and 25 percent are privately owned. Because each community has to provide wood for its own needs, it has its own forest administration and harvesting operations. Intensive road systems, built by each community over the years, have allowed the population to gain access to the forest for a variety of purposes.

Many European countries have developed a tradition of "every man's right" of free access to the forest, regardless of ownership. There are now civil laws that stipulate that "forests are open to anyone for walking about, picking berries and mushrooms, etc.," a right that is considered of the highest social value. Historically, many Europeans, particularly the landless industrial workers of the large cities, have had few places to go for recreation and relaxation. The municipal forests ringing the cities were the only available sites that offered escape from the urban environment. (Some historians believe that this free access has probably contributed to maintaining social peace by lessening the pressure of landless people for revolutionary land redistribution.) From the community forest's original importance as a source of lumber for construction, fuel for cooking and heating, game for the family table, and clean water, it has evolved into a place to stroll or hike, ski cross-country, or participate in other recreation.

This process has been accelerated by the prosperity of the last two decades. As car ownership in Europe became common, many people were quickly seduced into driving farther from home for recreation. But highways have become so crowded on Sundays that more and more families now prefer to leave their cars at home and to seek enjoyment in the nearby forests. Because most European cities and towns are much more compact than in America, the surrounding forests can often be reached on foot within a half hour.

Local and national governments have done a great deal of planning for the use of forest areas to meet the growing demand for recreational resources while maintaining a certain amount of timber production. Scenic automobile routes, foot and bridle paths, hiking trails, sports facilities, playgrounds for children, hunting and wildlife areas, and contrasting landscapes between forested and open lands have been developed in recent years.

The examples of four important cities demonstrate the European approach to managing metropolitan forests for the needs of the citizenry.

Zurich

The largest city in Switzerland, with a population of 435,000, Zurich covers 22,700 acres, 23.6 percent of which is forested—the same ratio of forest to total land area as for the entire country. Ownership of the forests, which range from about 250 to more than 3,600 acres, is divided between the city of Zurich, which is the largest owner, the canton of Zurich, private interests (these holdings are small), and the Swiss Federal Institute of Technology, Division of Forestry.

Zurich is a busy and prosperous metropolis, and its citizens demand a wide variety of services from the surrounding forests. The forests are almost the only reserve of open land. Much more than city parks, these forests, which are within one mile of the center of the city, give the residents of Zurich an opportunity for privacy and physical activity in fresh air and relative quiet.

East and west of Zurich, the forests protect the steep slopes of the mountains from erosion. The city's main source of water is the Zürichsee, but there are several substantial sources of water within the forests. Timber production within the city is estimated at 1.5 million board feet per year, yielding about $80,000, an amount sufficient to maintain the forests and to pay for other city administration costs as well. In the case of the school forest of the Federal Institute of Technology, the net income is used for forestry research.

Swiss law states that the amount of land area devoted to forest must remain the same. Any deforestation or land clearing must be replaced by an equivalent area of reforestation and in the same general vicinity. Transfer of publicly owned forests to private ownership is practically impossible. All forests must be managed on a sustained-yield basis, under the prescription of a working plan that has been approved by all owners, the forestry administration, and the cantonal government.

It appears likely that recreation needs will have an increasing effect on forest management practices. This forecast is underscored by the municipal law that governs the use of Zurich's forests for recreation: "Everybody may walk in any forest and mountain pasture and collect berries and fungi in accordance with local customs." Such traditional rights will probably be extended to cover more popular leisure-time activities.

Oslo

The city of Oslo owns a forest area of about 38,000 acres, managed by the Oslo Committee of Elected Councilors in accordance with the following directives:

1. To manage the forests in as professional and profitable a manner as possible, coordinated with proper care of the countryside.
2. To make conditions as suitable as possible for all-around recreation.
3. To adapt the management of the forests to meet the desires and requirements imposed by the health authorities to safeguard the city's sources of drinking water.
4. To make conditions suitable for the most abundant and varied animal life in the forests as possible.

The encircling forest areas—most of them less than a mile from the city center—are divided into units, some devoted chiefly to forest production and purposeful care of the countryside; others strongly to recreational purposes with the main emphasis on making the natural woodland as attractive as possible. Large unbroken deforested areas are avoided. The woodland is preserved in its natural state near ponds, marshlands, lakes, and other places with a particularly fine view.

Many miles of roads and trails are interwoven in the municipal forest area. Some are for vehicle use, and others are used principally for hiking and cross-country skiing. Some lead only to places of refreshment in the center of the forest. Great care is taken in the construction of these roads and trails to make them as unobtrusive as possible so that they blend into the landscape with a minimum appearance of human disturbance. When an area is damaged because of some construction, it is immediately revegetated. The city provides large parking sites around the borders of the forests.

Commercial enterprises are not permitted, but the city of Oslo has developed a network of inns in all parts of the forests. These inns give hikers an objective and spread the traffic throughout the different parts of the forest. Sporting grounds are provided for various forms of athletics: there are shooting ranges and areas for such winter activities as ski jumping, slalom racing, tobogganing, and flood-lit skiing. The administration also strives to create good game habitat, but the only hunting permitted in the municipal forests is for control of elk herds.

Frankfurt

The city forests of Frankfurt are world famous. Owned by the city since 1732, they have been under the management of a professional forester since that time.

Recreation has been the dominant use of the Frankfurt forests since 1927, and facilities are designed to appeal to people of all ages. Wood is the basic structural material of these facilities, and some are unusual in their design. For example, children's slides are made of carved-out logs, and jungle gyms out of branches and poles.

Frankfurt also provides an imaginative example of urban land converted into a natural area. Authorities turned the city dump into a recreation center by covering it with soil excavated from the construction of a subway system. This area was planted with trees and grass, and various recreational facilities were constructed for both children and adults. The dump covered about 60 acres—700,000 cubic meters of soil were required to cover it.

The idea came after World War II, when the rubble of bombed-out cities was moved out to the city limits and buried. Artificial hills were created, then planted, landscaped, and developed into parks and forests. Perhaps some of the city-dump problems in the United States could be solved in this way.

Paris

The forests around Paris occupy about 19 percent of the total region, with those devoted principally to recreation totaling about 140,000 acres. There are 35 individual forests, ranging from 60 acres to 42,000 acres and forming two concentric circles around Paris, one out about 15, the other 35 to 40 miles from the city. Many are very old and were originally the hunting grounds of royal families. The inner belt is composed mostly of deciduous hardwoods; the outer belt is a mixture of hardwoods and conifers.

Within two miles of the gates of Paris, the Meudon forest, an area of 2,750 acres, typifies the French urban forest. These woods are intensively used by Parisians plus about 180,000 inhabitants of surrounding small communities. The area receives about 2,200,000 visits a year, and 25,000 on peak days.

The Meudon forest is divided into three areas: parks, forest for walking, and undeveloped woods. The parks, located adjacent to residential areas, are designed to accommodate small children and their mothers. They are equipped with playground facilities and other open spaces for play, an occasional shelter, paths for strolling, and grassy fields. The parks take up only about 140 acres but are of direct service to the nearby communities.

The forest for walking, or Forêt Promenade, covers 1,100 acres, and its numerous wide footpaths, abundant gathering and rest areas for visitors, and comfort facilities are designed to accommodate about 20 persons per acre. At peak times the Forêt Promenade accommodates 20,000 people. This forest is cleared of all undercover to give easy access to all parts; openings are cut to create grassy areas.

The undeveloped woods preserve the character of a natural forest. They cover about 1,500 acres, are essentially steep, hilly land, and play an important role in the protection of watershed. Public access is limited; clearly prescribed paths and trails are not laid out because heavy use would cause erosion.

The Meudon forest is managed under a detailed work plan, recently revised to cover the 15-year period from 1970 to 1984. Careful studies were made, and financial plans prepared, to accommodate the needs of an expanding population.

The other thirty-four forests around the Paris area are managed in a similar but varied manner according to the characteristics of the forest and the nature of public use. The general principle of management of all these areas is to maintain the natural aspect of the forest insofar as possible and to safeguard it from the pressures of urban society that may seek to change it or cause it to deteriorate.

In Europe, authorities make a real effort to preserve and maintain the city forests. Food, recreation, and safety services are provided with no attempt at commercialization. People feel safe, as there is little crime or vandalism, and they exhibit a respect for the facilities provided for their pleasure and relaxation. The European experience with urban woods demonstrates that life in the city can be more civilized than that now endured by too many Americans. ☐

JULES ZALON

Bird- and People-Neighborhoods

by Robert D. Williamson

Rock Creek Park in Washington, D.C., is an urban green belt between two distinctly different residential areas—the teeming east side with its run-down apartments and wall-to-wall pavement and the shady, quiet west side. The area represents a cross section of human and bird habitat—from dense forests through wooded suburbs to crowded, multistory buildings. Many cities have similar large, forested parks, but Rock Creek Park presented an unusual opportunity to determine if there is a correlation between the number and variety of birds and the quality of the human environment. To test this theory I undertook a study of the distribution of a number of songbird species in the two neighborhoods and in the park.

In the early nineteenth century, financier Charles Glover, an avid proponent of parks, envisioned a park that would not only provide Washington's residents with a recreation area, but also beautify the city and increase the value of property along the valley of Rock Creek. After years of Congressional opposition, Rock Creek Park was finally set aside in 1890 and is now administered by the National Park Service.

Georgetown, to the west of the park, had been added to Washington in the eighteenth century. This area included houses with spacious grounds and lush vegetation to attract the wealthy. Georgetown today reflects affluence and cultural homogeneity. Its socioeconomic and ethnic composition is fairly uniform. The majority of its residents are upper-middle- and upper-class whites, and about half the population is single. Children are noticeably absent. Few families have incomes below $14,000; many have incomes in excess of $24,000.

Almost half of the housing units are single-unit dwellings. The small, usually old but expensive houses are packed closely together along quiet, narrow streets overhung with the branches of spreading maple and oak trees. Gardens, usually enclosed by fences, are beautifully landscaped and cared for. There are several modern one-unit structures surrounded by sprawling green lawns, shrubs, and trees.

The neighborhoods bordering the eastern edge of Rock Creek Park are composed mostly of renter-occupied housing units. Seventy percent of the residents are black, with incomes ranging from $5,000 to $10,000. About 88 percent of the buildings contain more than one dwelling unit.

Typical of the east side are two- and three-story row houses with an occasional large apartment building. The density of housing units is as high as forty dwellings per acre. These areas lack plentiful vegetation and adequate play space, and their streets, alleys, and other public spaces are inadequately maintained.

Each neighborhood has a characteristic flora: west of the park, coniferous trees—pines, hemlock, and spruce—and deciduous species such as maples, flowering dogwood, apple trees, oak, and American elm predominate. These species were also found within the park. The landscape around the homes includes several varieties of horticultural ornamentals—rhododendron, holly, forsythia—and a variety of flowering plants and grasses.

To the east, the sparse vegetation includes small ornamental pine and hemlock trees. Red maple, white oak, and black oak make up the small number of deciduous trees present. A few homes and apartment buildings use privet hedges as barriers around small lawns.

My study compared the numbers of cardinals, mockingbirds, catbirds, wood thrushes, house sparrows, pigeons, starlings, robins, blue jays, and song sparrows along park transects that extend into each neighborhood. It also attempted to relate the occurrence of birds to some habitat components, such as the volume, number, and basal area of trees, shrubs, and lawns, and also some human factors, such as area of pavement, density of housing, and two surrogate measurements of income.

The results of the bird census showed a distinct pattern. Such native species as the cardinal, robin, and mockingbird exhibited a preference for the wooded park and the residential neighborhood west of the park, where the relative affluence of the occupants allowed for lawns, yards, and extensive woody vegetation. On the other hand, introduced species such as pigeons, starlings, and house sparrows were best adapted to the areas east of the park characterized by high-density buildings and a lack of vegetation: pigeons found numerous nesting sites in the girders of bridges and the ledges of high buildings. Starlings and house sparrows readily adapted themselves to almost any conceivable location that provided some concealment, security, and support for a nest.

Cardinals were common in and west of the park, but their numbers declined rapidly east of the park. The number of deciduous trees present on study plots was a strong factor in the variability in cardinal numbers: cardinal distribution was reflected in the greater amount of deciduous vegetation west of the park. Cardinals also tended to prefer areas with private homes, rather than apartments, because the diversity of vegetation provided not only concealment for nests but also a variety of insect and plant foods.

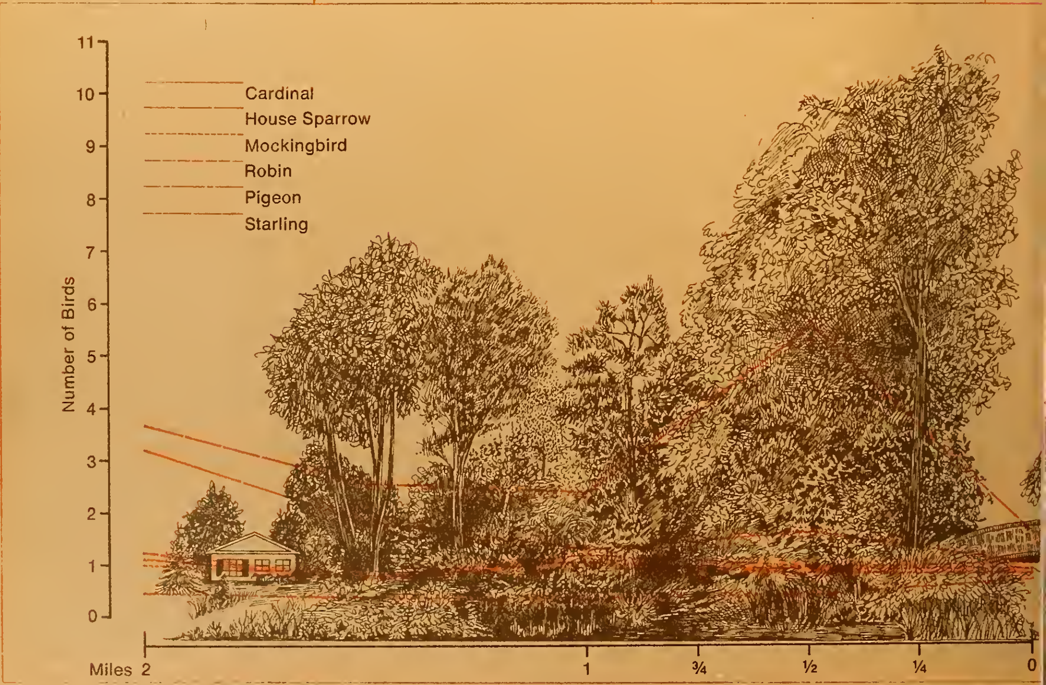
The planting of ornamental shrubs by Georgetown homeowners provided fruits and berries, as well as natural niches for bugs and caterpillars. These, in turn, attracted mockingbirds, which nested and bred in the vicinity.

Robins also were much more numerous west of the park and decreased in abundance with distance east of the park. Many of the west side residents were able to afford homes surrounded by green lawns. This type of habitat is a natural yielder of earthworms, a common food of robins. Most of the areas east of the park lack the lawns and decaying vegetation necessary for earthworms to survive.

Wood thrushes were found only in the area to the west of the park and in the park itself, although even there, their numbers were small. This species commonly builds its nest of grass, leaves, and bark fibers in moist woods or thickets near water (which is available in the park). The coniferous trees of the west side help provide the wood thrush with protection and a food supply.

Blue jays were most abundant west of the park, but declined in abundance and were virtually absent a short distance from the east side of the park. The jays west of the park flourished on almost every kind of digestible plant food—acorns, chestnuts, wild cherries, and hawthorns.

The lowland thickets along the east and west edges of Rock Creek Park proved to be an excellent habitat for catbirds. They utilized the shrubbery as a food supply and for protection. The creek in the park also provided water for drinking and bathing. This habitat also provided catbirds with a variety of



species of land and water insects.

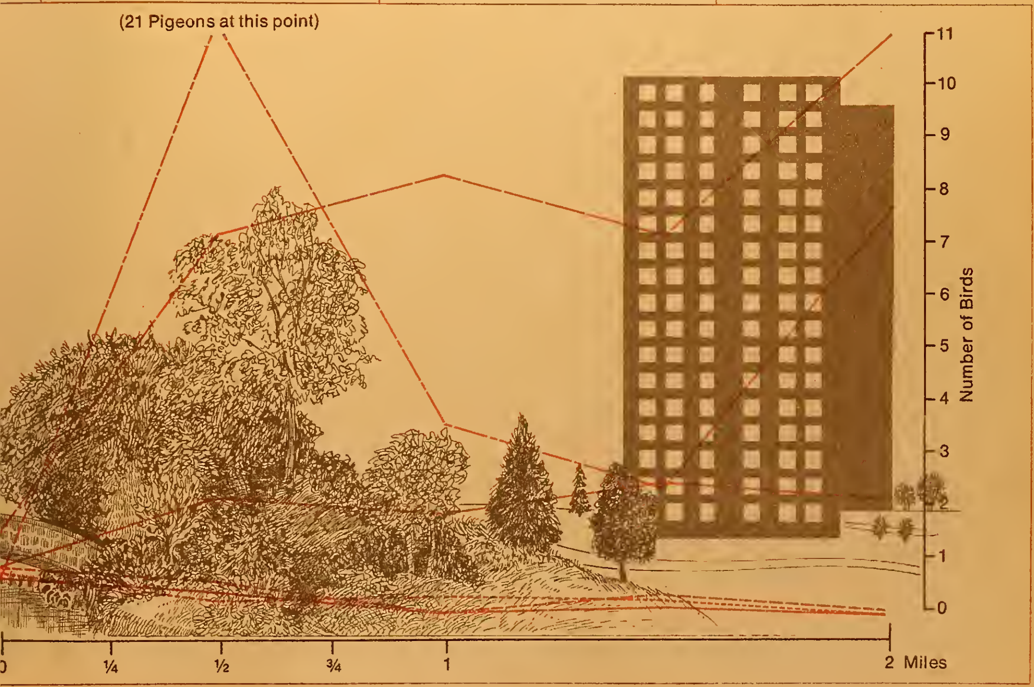
The territory of the song sparrow is chiefly decided by the male, although the female builds the nest. The female lays her eggs in a ground nest, usually concealed under unmowed lawn edges and low shrubs. The low-lying coniferous trees provide security and food for the song sparrow. Most of the plots east of the park lack this type of vegetative cover.

Starlings proved to be sociable birds and were more numerous on the more populous east side. Their numbers increased with distance from the park. This was a reflection of the species' adaptation to areas occupied by buildings and people.

House sparrows are also opportunists and were commonly found in both residential areas but were much more numerous east of the park. Their presence was correlated with dense housing where numerous niches are available for nest sites; they tended to increase in abundance with greater distance from the park.

Pigeons, predictably enough, were most abundant east of the park, especially in adjacent zones where they used the many bridges for roosting. Statistically, little could be said about their habitat preferences, although I believe the availability of roosting and breeding sites is most important in their habitat selection while vegetation is of minor significance.

Birds are obviously not randomly distributed throughout the city; each species has a preferred habitat to which it is adapted. These distributions may also tell us something of the quality of these habitats for man. Residents of the west side live surrounded by lawns, flowers, thick vegetation, and songbirds. Poor children living on the east side play on concrete, not grass. If songbirds find the east side unsuitable for existence, why should it be otherwise for its human inhabitants? ☐



The Cincinnati Raccoons

by Darrell L. Cauley and James R. Schinner

In 1968, a raccoon was found in the ventilation ducts of a high-rise office building in the heart of downtown Cincinnati. This incident, along with numerous other reports of sightings in the city, aroused our interest in the life history and ecology of urban raccoons, and with the encouragement of Dr. Jack L. Gottschang of the University of Cincinnati, we undertook a study of the raccoon population within metropolitan Cincinnati.

We chose for our study a 320-acre site in the Clifton section of the city. Although the entire area is residential in character, there is a decrease in population along a gradient from the more densely populated southeast section to the wooded northwest section. Two main wooded sections in the study plot provide natural raccoon habitat. One section is 13 acres in size; the other covers approximately 45 acres and is contiguous to a 60-acre wooded tract immediately north of the study area. Two permanent and three seasonal streams, along with swimming pools, fishponds, and birdbaths, are the sources of water for the Clifton raccoons.

At first glance, one would assume that the city lacks sufficient food, water, and suitable denning sites and should therefore have raccoon densities below those found in the wild; however, we found this assumption to be incorrect.

During a two-year period (1968–69), we captured 167 different raccoons in this area, and our records of their body measurements, weight, sex, and sexual condition revealed no significant differences from those of raccoons studied in the wild. But we did find significant differences in the density of these urban animals and wild raccoons. Previous studies of raccoons in their natural habitat have reported maximum densities of from one per 11.7 acres to one per 16.2 acres. Raccoon densities in the Clifton study area never were less than one per 9 acres. The highest density recorded for a single month was one animal per 2 acres. This occurred despite the fact that there are 993 human dwellings (excluding churches, commercial buildings, and schools) in the 320-acre study area.

The animals made good use of man-made structures for den sites and travel routes. We found them denning in sewers, refuse dumps, attics, garages, and chimneys, and one female even commandeered an unused sofa on the third floor of a house to raise her brood of four young. The trees in the two wooded sections, of course, provided a primary source of den sites.

Individual raccoons were radio tracked as they moved through the Clifton area to and from their dens in search of food. Some animals used storm drains as access routes to feeding and denning areas; others denned or possibly fed in them. One animal moved systematically from a garage den into the drains and remained there all night. Repeated efforts to locate this animal failed, and it is suspected that it fed within the drain system.

The home ranges and activity patterns of several animals were plotted by radiotelemetry to determine their life histories in the city. We learned that the movements of the individuals under observation were restricted to travel between their den sites and feeding areas, with none of the random foraging efforts characteristic of wild raccoons. Limited foraging occurred only at feeding areas.

Raccoons in the Clifton area depend on man for much of their food supply. A caretaker at a local academy collected the school's daily accumulation of garbage and fed it nightly to a steady stream of raccoons. Several homeowners also placed their refuse in spots easily accessible to persistent raccoons. Most residents enjoyed these visits even though rattling cans and the barking of aroused dogs sometimes became a nuisance.

Based on a variety of studies, the size of home ranges for wild raccoons varies from about 27 acres to more than 350 acres. The average home range of the raccoons in the Clifton area was 20.6 acres, with a low of ½ acre and a high of 50 acres. Urban raccoons appear to have significantly smaller home ranges and higher population densities than those found in the wild.

One factor that appeared to control this population was canine distemper, a highly contagious viral disease. Raccoons have been shown to be susceptible to distemper; in one study one-half of the experimentally infected animals died.

The potential importance of this disease in limiting the Clifton raccoon population became apparent in the fall of 1968. During October and November we collected seven animals that showed signs of the disease. These individuals were found dead or dying on neighborhood porches and in the woods. The impact of a canine distemper epizootic is demonstrated by several factors. For example, there was a sharp decline in our percentage of captures between March, 1968 (25 percent), and March, 1969 (2 percent). We also noted that the overall raccoon population in the study area declined from 145 animals in 1968 to 51 animals in 1969.

There were other sources of mor-

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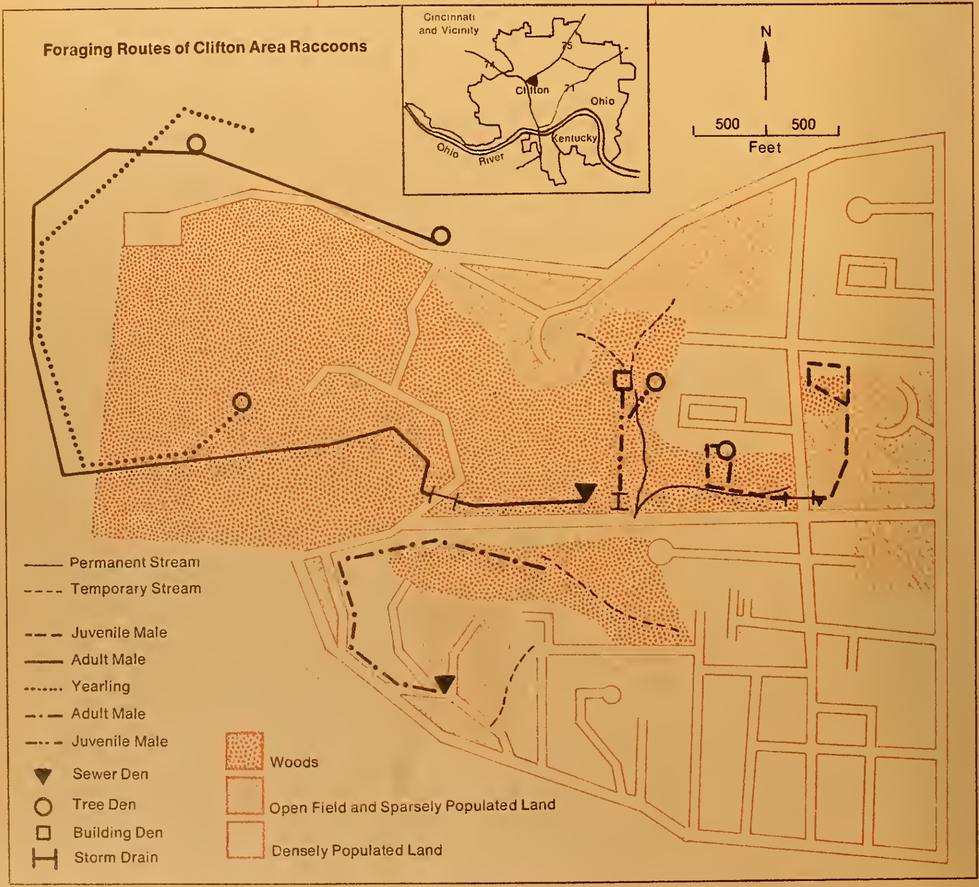
tality, but none of them could be demonstrated to be as widespread as distemper. Dogs were responsible for eight deaths over the two-year period, and raccoons killed by automobiles were observed from time to time on the roads traversing the Clifton area.

Many species of wildlife have suffered as a result of urbanization, but our research has shown that this is not invariably the case. The Clifton raccoons have adapted extremely well to city life. They feed almost exclusively on garbage, and den in attics, garages, and chimneys, as well as any available, suitable trees. Their use of the storm drains as travel routes makes them less susceptible to being run over by cars. The woods provide additional sources of shelter and food. Wherever these ingredients exist—and they can be found in at least some sections of all large cities—it should not be surprising to find raccoons in residence. ☐


Foraging Routes of Clifton Area Raccoons

Cincinnati and Vicinity
75
74
71
Clifton
Ohio
Kentucky
Ohio River
N
500
500
Feet
Permanent Stream
Temporary Stream
Juvenile Male
Adult Male
Yearling
Adult Male
Juvenile Male
Sewer Den
Tree Den
Building Den
Storm Drain
Woods
Open Field and Sparsely Populated Land
Densely Populated Land

Ecology of City Squirrels

by Melvin B. Hathaway

Because of the rising population with increased leisure time, there is a national need for more land where people can experience nature. Within cities there are many natural areas that could alleviate the demands presently being put on rural parks and wildernesses, but these sites have been sadly neglected. In addition to the esthetic value of trees and grass in these urban sanctuaries, wildlife—from squirrels and raccoons to birds and insects—could be observed for the wildness it represents.

To learn the ecology of one wild urban animal that has not been fully appreciated, I conducted a research project on the gray squirrel in a 733-acre cemetery in a midwest city. Portions of this cemetery have been maintained as burial sites since the early 1800s, other sections are currently being developed for such use, and the remaining area is mostly forested. Residential and industrial developments completely surround the cemetery.

While driving through the older sections for the first time, I was impressed not only with the peace and quiet, fitting attributes for a cemetery, but also with the natural beauty that had been maintained over the years. Most of the trees are large, many with trunks four to five feet in diameter, and provide a shady canopy over much of the ground. In addition there are many introduced tree and shrub species, which produce a kaleidoscopic color show, especially during the spring and early summer months. The well-kept lawns, together with the trees, gentle hills, and occasional ponds, create an atmosphere of serenity.

It didn't take long for me to realize that the cemetery harbored a large number of eastern gray squirrels (*Sciurus carolinensus*). Easily observed, this medium-sized rodent—scampering from ground to tree and from branch to branch—is a familiar sight in many urban parks in the East and Midwest. Yet little is known about its ecology and life history. Most park visitors are content to simply throw some nuts, popcorn, or, unfortunately, lollipops and other nonfood items at squirrels. An appreciation of squirrels as wild animals does not seem to have worked itself into the American park ethic.

With the superintendent's permission, I selected a small portion in the middle of the oldest section of the cemetery in which to conduct the study. The area, representative of the surrounding sections, is dominated by white ash, holly, oak, hemlock, pine, spruce, dogwood, and maple. In addition to a mixture of trees and shrubs, numerous plantings provide ground cover.

I first analyzed the gray squirrel population for comparisons with published data of populations from more natural environments such as extensive hardwood forests, semiopen brushlands, and abandoned fields. The results revealed that the cemetery's squirrel population was indeed high. There were 5.48 gray squirrels per acre: compared with rural populations, this figure approached the upper limits of any squirrel population studied. Apparently these squirrels had adapted extremely well to their urbanized environment.

Man's efforts to maintain the beauty of the cemetery had stabilized the habitat by stopping ecological succession at just the stage preferred by these animals. Without man's intervention, the area would probably evolve into a more typical beech-maple climax forest, one that would support fewer squirrels.

Other reasons for this high population are the introduction of new species of trees and shrubs and the care of the original species, which insure a diversified source of food. Since various plants produce edible products at different times, food of some kind is constantly available for gray squirrels.

Perhaps still another reason gray squirrels thrive in the area is that they are shielded by the boundaries of the cemetery. Visiting hours are strictly enforced by the cemetery personnel, thereby insuring that the hours before 8:00 A.M. and after 5:00 P.M. are undisturbed ones for the cemetery's wildlife. Even during the regular visiting hours, visitors are expected to drive slowly so as not to disturb other visitors. The animals are therefore not excited and endangered by the dogs, children, and high-speed cars that may plague squirrels in other sections of the city, including most parks.

Given these reasons for population growth, why aren't squirrel numbers even higher? What are the factors limiting the squirrel population? The diversity of plants in this area insures ample food, and there are more than enough denning and nesting sites.

One probable factor controlling the population is the incidence of disease. Although I did not detect any disease symptoms in the animals I examined, if a communicable disease did establish itself, it would spread to many squirrels because of the high density of the population.

Despite the greatly reduced speed limits on the cemetery roads, a large number of dead gray squirrels were observed on the roadbeds. The many animals observed crossing the roads and their apparent boldness and lack of fear of the slowly moving cars undoubtedly account for many of these kills.

A third limiting factor operating on this population is predation. On numerous occasions a red fox was observed in the study area. Although never more than one was observed at a time, differences in coat color and size indicated that there were several foxes operating in the cemetery. Both in the early mornings and late evenings, the foxes were frequently observed trying to catch chipmunks or gray squirrels that had been caught in one of my study traps. I suspect the foxes raided the traps quite frequently judging from the number of traps found rolled over, several feet in some cases, and sprung open at the end of a trapping period. On one occasion, I observed a red fox trotting across a section adjacent to my study area with a large gray squirrel in its mouth. This particular squirrel had not been taken from any of my traps as they were not set at the time.

The combination of disease, automobiles, and predators probably regulated the gray squirrel population within the cemetery. The number of squirrels was high, but relatively stable—the population did not build up to such an extent that out-migration became necessary. In short, they are a fine example of stable population dynamics in microcosm.

Within the confines of this large midwestern city, a relatively small pocket of wildness still exists, and the animals living there are behaving like similar populations in more rural environments. ☐

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Life and Death of the Lord's Woods

by Robert Arbib

I was nine years old that June afternoon so many years ago when we first discovered the Lord's Woods, and the world was unspoiled and filled with mysteries. My first two-wheeler, dark red and fast, had come with my birthday in March, and ever since that glorious day my world had been expanding.

Only yesterday I had ventured beyond the edge of my universe, out where Westwood Road ceased to be paved and wound into the endless green unknown of the forest. I entered the shadowed stillness of the wilderness in trepidation and in wonder, stopping to dismount at the first bend in the road, peering down the long green tunnel that lay ahead, wondering where, if ever, it ended; whether these woods might go on and on, from here in Nassau County where New York City ended and the suburbs of Long Island began, straight through to Kentucky or perhaps even to Pennsylvania. Then I pedaled home at full tilt to find Carl and plan an expedition. Explorers needed companions.

It was just as if someone had planned and laid out a city, not for people, but for birds and cottontails and butterflies. In midsummer the roads lay pale and seared, and each step kicked up a little spout of dust that hung on the air and drifted away slowly, like a captive cloud. Ranks of tall wildflowers pressed in from all sides—they were golden, orange, purple, and blue—dusty miller, melilot, goldenrod, asters, thistle, Joe-Pye weed, and in the damp ditches, tiger lilies.

At every corner a faded, tilting, half-hidden signpost proclaimed its identity for all the dragonflies to read: Dickens Street, Ibsen Street, Fiske Street, Island Avenue, Forest Avenue, Midfield Road. But at any corner, looking down any street, one could see only a narrow, overgrown track, wide enough for an automobile, and in the distance a gradual merging of the high green walls. On the lesser streets and lanes there was a grassy strip down the center, leaving just the two tire tracks. Here and there, back in the jungle enclosed by the streets, one might still see a little "No Trespassing" sign tacked to a stake or tree, with a lot number on it. Most had bullet holes.

It hadn't been so many years ago, perhaps six or seven, that the roads were cut through this Lord Estate, new street signs were erected, and the big auction sale was held out in the meadow on that summer day. The famous auctioneer came down from the city, and the crowd sat on camp chairs under the circus tent, or stood around mopping their faces under the sun, trampling the oxeye daisies and black-eyed susans. The men were in long shirtsleeves and high collars and straw hats, and the ladies had parasols and fans. The auctioneer bellowed into a megaphone like the one our school cheerleaders used. Some tables had been set up outside the tent for the buyers to go and sign papers.

The prices were high, the people all agreed. The auction sale went on for several days, and in the end all the lots were sold. Everyone knew that real estate was a wonderful investment and that lots in the suburbs would always increase in value. This was not Florida of recent memory with its boom and bust, its purchases unseen, its underwater swindles. This was beautiful, flat, wooded land—a millionaire's estate! You could buy it with a small down payment and take years to pay.

But then, some of the land proved swampy, and most of it barely above the water table. Times got hard and money disappeared, and suddenly no one was building homes. The people who bought lots on Fiske and Ibsen and Bryant and Howard and Jefferson gave up on payments of the taxes, defaulted, disappeared, or sold out at a loss. Here and there a house was built and occupied: four or five on all those blocks, and one or two others up in the higher oak woods, but these were large and costly ones, and not really part of the auctioned property. One of these impressive houses was later abandoned; the owner just walked away and left it to the mice and the squirrels, and it stood vacant and going to ruin until a family of squatters moved in one night, living for a while secretly on the second story, but eventually hanging laundry out of the windows as if they owned the place.

The birds and the animals and the weeds never lost the land. Each year they quietly won back more and more of the roads, as if trying to close them altogether and obliterate the whole idea. Sometimes people walked the lanes that were closing up; in certain places culverts under the roads had broken and water flowed across, making it impassable for cars. On Sundays sometimes, a property owner would drive out from the city and stop at Edward and Emerson, or Island and Holmes, or Ibsen and Longacre, and walk in to reassure himself that this property he had invested in so rashly was real, and did exist, and

From The Lord's Woods, The Passing of An American Woodland, *by Robert Arbib.*
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had not vanished into the air. To point to a lot sign from his car, or stumble through the underbrush in search of one, or perhaps even to nail a "No Trespassing, Private Property" sign to a tree. But the butterflies and the catbirds ignored it, and so did we. Soon it too would have a bullet hole or two.

In those days we were the real owners of this property. Often we would stop here, in a detour on the way to the woods, early in the morning when the bird chorus was at its fullest voice. Or we would scuffle along these roads at noon, with the summer heat beating down on our shoulders and the copper butterflies dancing along with us in the dust. Or we would come slowly in the evening, when the thrushes sang from the deeper glens, to put out sugar traps on the tree trunks for moths.

This city of no people, this crisscrossed, abandoned land of field, wood, marsh, and thicket we thought of as an extension of our woods. One of my classmates lived on the edge of the wilderness: we called it "back of Hellers." Often there were birds to be found there when our woods were silent: invisible birds that made the fields chatter and buzz; we were to learn their identities one by one, each a discovery to be celebrated. Sometimes we would come this way on our return from the woods; it was not the shortest way home, but any place without houses and people, with wild things and weeds that grew in jungle profusion against the backdrop of the towers of New York was a better way home.

How strange and marvelous it was that everywhere we walked together, somehow we seemed to find new places to explore, roads and paths that no one seemed to use, roads that led us on, farther than we planned to go, luring us beyond the next bend, the next clump of trees, the farthest field. It was exactly like our very lives, curious and fascinating, with each new day an exploration, a learning, a discovery, and a turning in the road. Straight roads that reached out to the far horizon were like dreams, like imagination, leading one further and further along to some unknown destination, some unexpected answer that might be waiting at the end of it.

At last we did come to the end of one road, to the finite answer to the indefinite question. Suddenly there was no more road. It ended simply in a wide sandy place on the edge of a creek as wide as a small pond, with the sea of marsh reaching beyond it for miles. Two black ducks sprang upward as we came up to the water's edge and fled with a rush of wings and some loud complaining. Nowhere else was bird, or sign of life, or sound, under that enormous, unreachable, unthinkable, unbounded blue bowl of the sky.

All that long and lazy summer we explored our woods and its perimeter, expanding the world we knew; rode our bikes to its edge, then hid them in the jewelweed and continued through on foot. We walked down all its streams, followed all its paths to their endings or meetings, discovered glades here and pools there, marshy patches with cattails in them, a sandy place we called the Cherry Desert, walked along the farm road that skirted the north edge of the woods (years later we would learn that it had a name: Hungry Harbor Road). It was a road to nowhere, winding past a farmhouse at the edge of high oak woods, then cutting through a dense stand of second growth and tangle to a bend where a little red house stood behind one towering spruce tree, in a sea of junk. Whoever lived there—and it seemed to be a man with a disfiguring skin disease and several angry police dogs, fortunately tethered—either dealt in junk or simply had a littered way of life. The magnificent spruce was a landmark at least a century old, common to many of the older farmhouses in the community. They had been imported, it was said, from Norway by an itinerant nurseryman who peddled them, door to door, from his wagon.

Although we invented our own names for the topographic features of our world, more as a convenience than the just due of the explorer, others before us had exercised these rights, and the most prominent features of the landscape had already been named. We called one stream Teal Stream and did not learn for thirty years that it had been named Doxey's Brook long before we were born. That summer we explored its entire length, past Three Bridges, the Stone Bridge, Stepping Stone Island, and out into the marsh, discovering there a fine, wide swimming hole with a tiny sandy beach, shaded by one stunted cherry tree covered with poison ivy, remote, invisible except to hawks and swallows. Beyond the swimming hole Teal Stream slid westward again and joined Foster's Brook, deep in the salt marsh. And there, intriguing and mysterious, tilted up on mud and marsh, burned out, but still identifiable, its huge bolts and nails rusting into skeletons, lay the barge.

How it came this far upstream, on what wings or unimaginable high tide, to become lodged and abandoned miles from deep water, we never could understand. But we wove a story around it, as we did with all our landmarks: Washington's Barge, we called it. Used to smuggle guns to the rebels who were working underground in Tory-held Long Island during Revolutionary days. Brought in on a high tide from Jamaica Bay by night, stranded there in the morning, its cargo delivered along the secret paths of our woods and others that joined in a network across the island. Then, years later perhaps, burned when the marshes burned, as they did every spring. We knew, of course, from Mr. Perry's history course that the Loyalists had held tightly to Long Island throughout the Revolution and until 1783, after that disaster to Washington on Prospect Hill, but we knew too that there had been rebel activity behind the lines and this barge had played a part! Why, Mr. Hewlett down the street was a direct descendant of a Tory colonel, Richard Hewlett, and he was a spy too; my father insisted that the descendants of anti-independence ancestors should never have been granted the right to vote, for they tended to vote Tory still.

That summer too we moved our boundaries outward, Carl and I, or Ted and I, or Johnny and I. Now we had defined our woods and knew what was beyond it on all sides: farms to the north, marsh to the west, our village to the south, and grassy fields across Mill Road to the east. Not, as we had first thought, trackless wilderness in all directions, but more like a spreading sanctuary surrounded eventually, by places with people in them, people who knew little and cared less about this place we loved. Some knew it as the Lord's Woods, but most called it, if they knew of it at all, the Waterworks Property, or Woodmere Woods.

There was no pressure on the woods in those earliest years of ours. Each of the suburban communities around us was a compact, tailored island unto itself, surrounded and separated from its neighbor by a green belt of farms, fields, and woodlands. The marshes were untouched and unspoiled, except for the flat ditched meadows where the salt hay was harvested. Now and then, as we were growing up, a new house would appear on one of the vacant plots to be found on almost every block even in the heart of the village, or perhaps an entire street of houses somewhere on the edge of town. But our woods were inviolate; the Lord Estate was languishing; soon even the golf course was abandoned. We roamed them all now almost as our private domain; rode our bikes too to more distant hunting grounds: the creeks and marshes along the bay at the southern edge of the village, the marshes and ponds beyond the farms to the north, the beaches across the inlet where we could look out across the ocean, all the way to Spain!

One of our pastimes of that summer was the aquarium. I had acquired an old tank somewhere, and so had my two friends and classmates, Johnny and Beano. Together the three of us made a series of expeditions, hung with bottles and dip nets, into the woods. Sprawled along the banks of Teal Stream and stripped to the waist, we would lie in wait for killifish, or water striders, or any freshwater life we could find. Now chasing whirligig beetles across the surface of the brook, now delving deep into the muddy bottom to come up with a giant water beetle, a crazy diving water beetle, or a treasured back swimmer. We took them all: nymphs of dragonflies and caddis flies, tadpoles in all stages of development, once even a prized baby pickerel. We brought them home (some died from the rough ride home on the bicycle), emptied bottles and jars into the tank that stood on my windowsill, watched fascinated as beetles, each with a taillight bubble of air, zoomed in wild arcs across the tank. The surface bugs—water striders and

JULES ZALON

whirligigs—died first. Others lingered, to succumb to natural causes or the rampant cannibalism that cannot be controlled in a single small tank. The more aggressive beetles, the back swimmers, and the tadpoles thrived for a while, as the algae flourished in the sunshine and the water turned the color of pea soup. Eventually, as they usually do, the aquarium died and was carried out and emptied, only to be filled again the following summer. But it had added another dimension to the world around us.

The woods! A green, gold, scarlet, multicolored wonder of a world, ancient and yet ever changing, constant and yet filled with surprises, setting for dreams and fantasies, schoolroom without books, a sanctuary for birds and mammals, fish and crawling things, bugs and boys. Beautiful in every aspect and in every week of the year, and more prized because it was at once so accessible and so remote from the outside world. We had no words in those days to say how we felt about the Lord's Woods, but we cherished them. They were truly at the center of our existence.

Epilogue

Soon after World War II, where long there had been one or two houses tucked along a leafy lane, now suddenly there was a row—crowded picture window to picture window—three, four, six, ten. Down Longacre or Howard or Derby Avenue and through the tall oaks back of Heller's all was clamor and destruction. The contractors had moved in like an occupying army; truckloads of lumber and brick and pipe and concrete blocks lay about waiting to be pieced together.

All along the boulevard, signs sprouted, pointing to elegantly named model homes: the Dorchester, the Mayfair, the Park Lane. On the weekends, young couples with their parents and a child or two in tow disgorged from their cars to peer into closets and admire the raised dining area with the wrought iron railing. Almost every week new ground was invaded, the trees and shrubs bowled over, the tangles of blackberry and grape rooted out and obliterated.

Now all those grassy lanes we roamed as youngsters, chasing the meadow fritillary and the spicebush swallowtail through canyons of wildflowers tall as we were, were widened and paved and lighted and assumed the banal conformity of suburbia. Some of the builders had left the taller trees to shade otherwise bare plots, but the red maples soon died off, smothered by the sandy fill, the asphalt driveways, and the lowered water table. If the new owners wanted shade they had to plant their own trees, first paying to have the dead monuments removed.

The newcomers had lived all their lives in apartment houses. They judged a dwelling by its interior amenities: the number and size of the rooms and closets, the work-saving features such as the garbage disposal unit, the musical door chimes, and the real wood-burning fireplace. Of course, their first glimpse was a shock—that cleverly distorted rendering in the ad made the little Cape Cod box look enormous, under towering trees and so beautifully landscaped, and here it stood under the hot sun, with its sad little row of arborvitae and laurel "landscaping" and the bare front lawn from which, soon, would sprout thirty varieties of hardy weeds and the builder's tender rye grass, in that order.

In the years of the late forties and the fifties, the face of our world changed completely. What had been sleepy semirural villages, each separated from the others by an interval of woodlands or farms and meadows, slowly spread out and merged with one another, until the entire south shore of Long Island was one suburban continuum.

With this tremendous surge of immigration and building, the Lord's Woods stood ever more isolated, an island of wilderness in a sea of rampant suburbia. In all that south shore landscape, this was the only place where one could escape the frenetic world and be an Indian brave or a Thoreau, a Daniel Boone or an Audubon, or just a child learning about the world around him.

Although besieged and battered, the woods were still there. If you flew into the immense new airport (Kennedy) that had annihilated all those miles of marshland we had roamed for years—the Old Mill, the Idlewild Golf Course, the hidden creeks and bays west of the turnpike—and looked down just before landing, you could see the unbroken canopy of forest that was the Lord's Woods, a dark green preserve, geometrical in shape: an anomaly, hemmed in by highways and by rows of boxes. But it was still there. The cattail marsh, the Thrush Woods, the Green Cathedral, the Cinder Road, the Deep Ditch, Beech Point, Stepping Stone Island, Three Bridges, Teal Stream—still there in spite of storm and fire, vandalism and power line, progress and highway, population explosion and home development. One emerald gem shining in all that clutter.

And then some distant, unknown owners moved in to doom it. □

Adventures in a Wooded Wonderland

by Roger Hart

August 31, 1:00 P.M.,
sunny and hot.

It is not clear what system Peter uses to determine the time of day, but certainly the state of his stomach is an important element.

I'd spent an hour searching for him because I wanted him to take me to his favorite places. Finally he came whipping along the road on his bike and, in anticipation of our expedition, scoffed his lunch. First, he planned to take me to his new fishing place. "Did you see the path with the stick across it when you were looking for me? That's my path; my sister and I made it."

The broken branch that served as a gate seemed like any other along the stretch of highway flanking the river. But once Peter had pointed it out, the "gate" and the line of beaten-down grass leading to the river were clear. He closed the gate behind us; it was like entering Peter's estate. This feeling was transmitted by the intimate way he moved through the long grass, which was as tall as his shoulders and, at the bottom of the bank, by the selective route he used to lead me across the river. Jumping along the bank from rock to rock, we headed toward the fishing place. Suddenly he caught sight of a shale bank on the wooded edge of the river and immediately changed direction toward it.

Crouching low on the bank, Peter examined the remains of a model landscape, all but destroyed by yesterday's rain, which his sister and he had built out of shale and twigs. "That's New York up there between the two rocks, and that's New Hampshire with all the roads going over the wooden bridges, and down here is the road to our cove." A dug-out area was a hotel; a pile of twigs, a lumber yard.

Chattering away, he hurried me along to his fishing place, convincing me it was the *fishing place and that no one else knew about it.*

Days like this with eight-year-old Peter were part of two years of field investigation into the exploration and experience of the landscape by children as they develop from birth to eleven years of age. Ironically, more is known about the relationship of baboons to their habitat than of the activities of children to their outdoor environment. It was important that I spend an extended period of time with a group of children living in a small, distinct environmental unit, so that I could monitor their movements and behavior and obtain reliable data. I selected Wilmington, Vermont, for the study because it not only met these specifications but also incorporated many characteristics of an urban environment.

For their social and emotional development children need a physical environment that they can comprehend and within which they feel competent and secure. They also have an urge to explore the landscape; this is related to their need to experience the diversity and extent of the components of their environment and to see these as part of a whole.

The need to feel effective as an agent of change is another strong factor in the healthy development of a child. Compared to the complex and ever changing world of people, the natural environment remains relatively stable. A child can immediately see the transformations that he has effected. I have observed that children from about the age of three freely and frequently modify the environment if there are suitable areas available.

Children will not manipulate or modify an overtly cared for and guarded landscape. Manicured lawns, miniature trimmed trees, and the absence of dirt piles, surface water, and large trees all convey a strong message to a child—"do not touch." This is the situation in most new suburban housing tracts. In this respect the children of impoverished inner-city areas have a richer environment in abandoned lots containing piles of dirt, scrap wood, and other materials suitable for modifying the physical landscape (although such areas lack the special qualities—trees, water, varied topography—that natural elements possess).

The range a child is allowed to travel without accompaniment is limited by parents for a variety of reasons: inferior ability to deal with traffic and the desire to avoid unfavorable social influences are among the most common. Also, because children have to squeeze much of their play into short periods of time defined by institutional and family schedules, they must play within their neighborhood. In this defined space, a child must find a landscape sufficiently rich to satisfy the desire for free exploration, discovery, collection, and creation.

Children's needs for a variety of experiences are usually thought of as being provided for by such institutions as playgrounds, organized sports, schools, camps, and clubs. Such solutions, however, lead to more compartmentalization, segregation, and specialization of children. Their desires for play are not sufficiently regular or planned to enable them to prestructure all activities with their friends. Many of a child's most exciting games or projects happen by chance.

Social development may be fos-

tered if children have free access to areas where they can meet casually and engage spontaneously in cooperative activities. I have observed cooperative play to be particularly encouraged when sand or dirt (ideally with water) is available as the play medium. A recent project on the sandbank behind the local elementary school engaged as many as thirty children under nine years of age in the building of an elaborate stream system. Dams, bridges, tunnels, islands, and waterfalls were part of the intricate network. Such social cooperation among peers is unknown in conventional playgrounds.

Children also need places where they can be alone; I have watched children many times playing alone in the dirt or by a small pool of water. Freedom from interruption and interference by adults is important; time to reflect on experience and develop a personal ordering of his world is essential to a child. By experiencing and re-creating the world in this way, a child can develop the individuality that is needed for healthy relations with others.

The physical environment also plays an important role in supporting a child's emotional security and developing a sense of personal identity. Children who encounter frequent changes of residence or who live in neighborhoods that suffer from heavy wrecking and building activity will find it difficult to construct a stable image of the environment. Continuity of experience is most important. I have observed, for example, that a child can develop such a strong attachment to a tree that its removal, if necessary, must be carried out with care and understanding. It is an indication of the need to give order to the world that a child's most frequently observed creative activity out of doors involves the building of miniature landscapes—cities, houses, garages, and airports.

The natural environment offers a wealth of play potential for young children, with trees and small patches of water the most valued elements. One tree can engage a child for days at a time or, periodically, over a span of years. Manufacturers of playground equipment have found it impossible to re-create such richness. The children of Wilmington demonstrated to me that there are countless routes up "a good climbing tree"; many notches, cracks, or rough spots can be used, depending upon the child's desire for challenge at any time. Any kind of bush or tree allows children to exercise great creativity in the construction of houses, forts, tents, and imaginative laboratories. A mature tree is excellent, of course, for hanging a rope swing and has the added attraction of a host of insects.

Children do not need large wooded areas; in fact, many play only on the fringes of woods. But the pressures of land use and an unwillingness to recognize the importance of natural elements have made them scarce in most urban areas. Natural elements are systematically removed from suburban areas and urban playgrounds in the name of esthetics, durability, and safety.

One solution to the lack of suitable natural areas for city children are "adventure playgrounds," in which they are given the opportunity and the materials to dig tunnels, plant gardens, and build places by themselves. These playgrounds try to create in microcosm the qualities of a town most valued by children. Trees, varied topography, earth, and building materials are essential elements. Adventure playgrounds were introduced in Denmark during World War II and caught on in England during the 1950s, but the concept has been slow to take hold in the United States. A major criticism by adults is that these areas are ugly. The inclusion of trees could do much to alleviate this problem. It is doubtful, however, that such playgrounds could be created in sufficient numbers to be freely accessible to younger school-age children for they require the expense of a permanent and competent supervisor. Small natural areas, or "minicommons," spaced every few blocks and unsupervised except for the care of trees, could provide a supplement to larger, more widely spaced adventure playgrounds.

One hundred and forty years ago Friedrich Froebel, the German educational philosopher, introduced the concept of kindergarten into education. His ideas anticipated later findings in stating that a child is by nature a doer, and therefore learning is secondary to activity, out of which it grows. Froebel also emphasized the importance of experiencing the harmony of the natural world in the development of the child. Many kindergartens and schools still lack these qualities, but the city designer also has a responsibility in this matter. For the richer and fuller development of metropolitan children, more minicommon lands, featuring an abundance of trees, water, and soil, should be made as accessible as the wooded adventureland available to the children of Wilmington, Vermont. Children do not need to be taught how to explore and learn, they will do so naturally given an environment that will allow it to happen. □

Trees and Urban Climate

by Saul Rich

The large volume of toxic gases and airborne particles produced by human activities has become a matter of grave concern. But despite remedial legislation, the injection of pollutants into the air will probably not subside in the near future.

In many localities, symptoms of injury in plants and trees are the first indication of the presence of air pollutants. Major pollutants discovered in this manner are sulfur dioxide, hydrogen fluoride, and photochemical oxidants—ozone and peroxyacetyl nitrate—produced by the action of sunlight on mixtures of other gaseous impurities, principally those produced by automobiles. All these pollutants must enter the leaves of plants in order to injure them. This raises the question: Can plants bathed in a polluted atmosphere remove enough of the toxic gases to benefit man without injuring themselves?

To find some answers, Paul E. Waggoner, Harley Tomlinson, and I made a recent study at the Connecticut Agricultural Experiment Station on the uptake of ozone by leaves.

We chose ozone for our study because it is recognized as the air pollutant that causes the greatest damage to plants in the United States and other industrial nations. Many conifers and some deciduous trees are damaged by concentrations of this toxic form of oxygen equal to, or less than, that found outdoors during periods of air pollution.

We found that the uptake of ozone by leaves is essentially an exchange of gas between leaves and the atmosphere. Because of this, the ozone uptake mechanism must be regulated by the same factors that control the exchange of other gases such as water vapor.

Projecting our laboratory data and observations with the aid of mathematical models, we attempted to construct a picture of how the ozone uptake process might work within a canopy of trees.

Our conclusion was that as a heavily ozone-laden layer of air filters down through the treetops, a portion of the ozone enters the leaves and is removed from the air mass—resulting in a gradual decrease of ozone near the ground. This happens only when the stomata, or breathing pores of the leaves, are open. As almost all stomata require light to open, and since ozone is produced in sunlight, the ability of foliage to absorb ozone is greatest during daylight hours. The total amount of ozone that trees are able to remove depends on a number of factors: the original concentration of the pollutant in the air mass moving down through the canopy, the height of the inversion layer, wind speed, turbulence, amount of available light, temperature, tree height, the size and shape of leaf surfaces, and the stomatal aperture. The actual proportion of ozone removed can range from 0 to 20 percent of that present in the air above the treetops.

It has already been demonstrated that the phytotoxic pollutants occurring most commonly in the air must enter the leaves through stomata in order to cause injury. But it is entirely possible that some plant leaves have materials on their exterior that can react with and either fix or destroy such air pollutants before they enter the leaf. These pollutants, injurious if taken into the leaf, might be removed from the atmosphere without poisoning the foliage. For example, experiments have been conducted in which a number of tree species were exposed to a small, nontoxic dose of radioactively labeled sulfur dioxide, and analyzed for sorption by the leaves. It was found that the greatest amount of SO_2 was sorbed by birch, beech, and hornbeam. Lesser amounts of SO_2 were sorbed by elm and willow trees. In these experiments the radioactive sulfur penetrated into the leaf tissue of only the elms and beeches. It is possible then, that the tree foliage removes gaseous pollutants from the air even when the obvious signs of leaf injury are not present.

There are other beneficent effects of trees upon metropolitan microclimates. They provide shade and can cool air locally by evaporating water from their foliage. This water loss, or transpiration, is a normal process by which a tree moves water and nutrients from the soil into the trunk and branches. A large tree may transpire 100 gallons of water a day, and with the shade, cool the air under its canopy by as much as 20°F.

Wherever protection is needed from strong winds, tall, deep-rooted trees can serve as windbreaks. Also, properly spaced trees of sufficient height can reduce noise pollution. It has been estimated that each 100-foot width of tree belt absorbs about 6 to 8 decibels. If one considers that a busy highway can produce 78 decibels, it is obvious that trees growing between a residential neighborhood and a superhighway can offer an acoustical benefit.

The various benefits provided by trees help to make the metropolitan environment a more comfortable place for people to live; and, as we develop more sophisticated techniques for accurately measuring these contributions, the typical view of a tree's value is bound to be enhanced. ☐

CARY S. WOLINSKY

The Chicago Forestry Scheme

by Frederick Hartmann

Chicago has a thriving new business, based on a steady, dependable supply of raw material that has existed within the city since its beginning. The resource is the city's three-quarter of a million trees; the entrepreneur is the Bureau of Forestry, Parkways and Beautification of the City of Chicago; the income-producing product is wood fiber in log or chip form. This urban forestry operation is saving Chicagoans thousands of dollars annually, and may in the future produce much greater returns.

The chain of production is breaking many of the traditions concerning trees in metropolitan areas.

Traditionally, a city's trees have been viewed as esthetic embellishments. But trees eventually age and become a problem for property owners and city administrations. After strong winds, ice storms, or outbreaks of tree diseases, streets, sidewalks, and lawns are strewn with the skeletons of trees that succumb to the elements after years of neglect and pollution. During fierce storms, the giants begin to fall apart; and as their limbs plummet toward the pavement, they knock down power lines, dent the roofs of cars, block sidewalks and streets, damage homes, and threaten lives.

The problem for the city and for homeowners has been to dispose of the remains. City work crews, dispatched to saw and chop away at the tangled menace, often work overtime to clear the debris, while homeowners have to hire professional tree salvagers to remove the trunks and branches cluttering their yards.

In the past, Chicago, like most cities, simply burned this debris. But in the mid-60s the problem was magnified when Dutch elm disease hit the city. Disposing of many thousands of dead trees in a short period of time proved to be a monumental—and expensive—undertaking for the city's Bureau of Forestry. Burning the mounds of wood created a heavy pall of smoke, which hung over the city and mixed with industrial and home effluents. In 1970 anti-air-pollution legislation banned this kind of burning within Chicago's city limits. Sanitation officials then disposed of tree litter in landfills, an alternative that soon proved impractical. The cumbersome material quickly clogged, rather than filled, the available sites, which were rapidly depleted. Furthermore, because wood decomposes slowly, the landfills would be too unstable to build on for many years.

It has been estimated that about 295,000 elms, with a minimum trunk diameter of 20 inches, will die of Dutch elm disease in Chicago between 1968 and 1978. In 1969, the base cost of removing a dead elm was $4.00 per inch of trunk diameter. Over a ten-year period, it would cost about $24 million to remove 295,000 trees. In addition, the expense of removing other species, plus a replacement cost of $20 per new tree, bring the total expenditure to approximately $40 million in ten years—a significant drain upon the corporate, vehicle, and forestry tax funds that currently provide the operating budget for the city's Bureau of Forestry.

An imaginative, professionally trained forester, Charles Stewart decided to determine whether the dead trees were marketable as wood fiber or timber. He learned that a local manufacturer was producing roofing shingles made out of a heavy felt paper composed of wood fiber from waste paper, rags, and wood chips and impregnated with asphalt. The wood chips for this operation were imported into the city. Since Chicago had a plentiful supply of raw material and a disposal problem, the Bureau of Forestry purchased a chip-harvesting machine and arranged to supply chips to the roofing shingle manufacturer.

In 1972, the Bureau of Forestry removed 21,000 dead trees from the streets and parks of Chicago. An estimated 15 to 20 percent of this wood was turned into chips and sold, and the bureau realized gross earnings of more than $22,000 from the operation. This is only a small part of the bureau's 1973 budget, which included: planting 40,000 trees and related landscape functions, $547,500; removal of an estimated 25,000 trees, $1,727,205; removal of tree stumps, $302,800; spraying against Dutch elm disease, $90,300; tree-trimming operations, $2,511,000; funds for emergency clearing operations after storms and other natural disasters, $528,600. Income from the wood chip operation should reach $125,000, a 500 percent increase.

The bureau also has other plans for generating income. As one example, many of the tree trunks were too large for the wood-chipping machines, but the quality of the timber was high. Bureau workmen cut these trees into seven-foot logs and, pending a profitable market for them, stored them in a holding area. (The logs from American elms were sprayed to kill the Dutch elm beetle vector and prevent its spread.) Discussions have been entered into with several regional wood users to purchase these logs, and there are indications that the mills will be able to use the lumber.

With the growth of commercial possibilities the bureau now assigns work crews to trim, top, and prune trees in specific districts. The smaller diameter material from these daily operations is chipped at the site with a brush-chipping machine, while larger diameter material is hauled to the central mill. This year the city has a new contract to supply chips to a firm in Madison, Wisconsin. The distribution system worked out with the new company can also be used to transport the stockpiled saw timber to mills outside of Chicago at reasonable rates. The economics of this potential income producer are increasingly favorable (especially considering the skyrocketing costs of lumber), and trial loads have been shipped to the mills.

CARY S. WOLINSKY

Paper producers in the Chicago area are now looking to the city's trees as a possible resource for the production of such low-grade stock as cardboard, kraft, and building papers. Even material from stumps and brush that couldn't be used in the past and that was either burned or dumped in landfills outside of the city can be utilized for the manufacture of these papers.

Commonwealth Edison of Illinois has initiated a pilot program to burn the city's refuse for the production of electricity. Stumps and other debris from the city's trees may figure in this plan.

More volume is needed to increase the profitability of these various programs. Here the view of the metropolitan woods as a harvestable and manageable resource shows its practicability. The Bureau of Forestry plans to make its chipping and disposal system available to all sources outside of its jurisdiction. One possibility under consideration is a cooperative agreement with the Cook County Forest Preserve District, which encompasses a significantly larger area than the city; another is the use of trees on the lots of the city's 74,000 owner-occupied homes. A system to remove the dead and diseased trees from private properties could result in large savings for the homeowners and additional income for the city.

The bureau has already launched a campaign aimed at salvaging wood and wood fiber debris currently being scrapped by other city departments and private industry. It plans to channel this material into outlets that can utilize it most efficiently and economically. The bureau also has offered to convert the wood wastes of surrounding municipalities in the Chicago area, working them into the already established system.

The growing emphasis on the city's trees as income producers to help pay for their planting and maintenance is beginning to affect the operating philosophy of the bureau. Stewart, applying the management concepts of large-scale commercial timber operations, points out that "as urban trees grow and mature, their maintenance costs increase, and they become hazardous. Eventually the trees must be removed. Why not establish cutting rotation schedules and harvest them at an optimum time, before maintenance costs rise and when dollar value is maximized?"

A major problem affecting this approach is that the sight of a tree being cut is offensive to many people.

The ideal, according to the bureau's position, would be to eventually develop a sustained-yield system in which the revenues earned from the tree-harvesting programs would pay for removal of all dead trees, as well as for their replacement and maintenance.

Long-range plans include a computerized inventory of every tree in Chicago—by species, age, and condition. Cutting schedules would be geared to the optimum time for harvesting the trees, and replacement of new trees would occur more quickly. The replacement stock would feature a greater variety of species, including some more resistant to pollution and others that will grow faster and reduce harvest rotational times.

As this concept in urban forestry emerges, it appears that the future of Chicago will include more trees, in healthier condition, and at less cost—benefiting Chicagoans esthetically and financially. □

The Twenty-nine Tree Home Improvement Plan

by Brian R. Payne

The amenities provided by trees in residential neighborhoods are sufficiently sought after to make nurserymen a major influence on the metropolitan landscape. Shade, wind reduction, screens for privacy, an environment for wildlife, climbing areas for children, and natural beauty are the motivations behind the annual purchase of veritable forests by American homeowners. Residential trees also have drawbacks, such as leaves to rake, damage to sidewalks, drippings on cars, and dead branches that fall on houses. But the widespread presence of trees in residential areas indicates that most homeowners feel the advantages outweigh the disadvantages.

The economic importance of trees near homes is often overlooked. When decisions affecting land use and value are made, there is a tendency to place much greater weight on measurable dollar costs than on so-called intangible factors, such as trees. However, a measure of the actual value of trees in dollars and cents could provide homeowners, land developers, and city planners with a new appreciation of existing trees.

An idea of the dollar value of residential trees can be ascertained by purchasing even small trees from a local nursery. But larger trees, which have been growing on the same site for years, do not have an easily established market price. They are not generally bought and sold except as a part of the property on which they are growing. Thus, the value of such trees has to be measured by their contribution to property values.

To do this, a research team from the United States Forest Service selected a 12-acre tract of undeveloped open land suitable for building in Amherst, Massachusetts, and constructed a scale model of it. After photographing both the actual site and the scale model, we "planted" varying numbers of trees on the model and rephotographed it. The photographs depicting the resulting landscape variations, together with property descriptions, were shown to real-estate appraisers who were asked to estimate the per acre value of the land.

As open land, the parcel was appraised at $1,500 per acre. When two-thirds wooded, it was appraised at $2,050. On the average, the results showed that trees contributed as much as 27 percent of the appraised land value.

Eight room French Provincial; appraised value $39,100.

BRIAN R. PAYNE

A related study of half-acre lots and houses with an average property value of $34,000 was conducted with real-estate appraisers and homeowners in Amherst. The results showed that trees contributed 7 percent to the value of the average property and as much as 15 percent to some lots.

The contribution of trees to total property value depended on the number and size of the trees. Only trees 6 inches or more in diameter had any effect. For half-acre lots, the first tree of this size added about $300, the tenth tree added $200, the twentieth added $100, and the thirtieth added nothing at all. Adding more than thirty trees to a half-acre lot actually reduced the total property value; a maximum of $4,300 was added to property value with twenty-nine trees per half-acre lot. The values of the trees did not vary with the value of the properties or homes.

For home developers, there is a quick lesson in these results: a practice of leaving trees on land that is subdivided for house lots may show immediate profit. Many housing developments start with wholesale land clearing, presumably to reduce building costs. But if the cost of protecting trees while building is less than their addition to property value, it would be more profitable to leave the trees rather than to bulldoze and burn them. The builder who is aware of this possibility may increase his profits while contributing to a higher quality environment.

Not all of the benefits from residential trees can be capitalized into the value of private properties. The dollar figures from our research underestimate the true economic contribution of residential trees. Not accounted for are the beauty that trees provide to passersby, the shade cast on neighboring property, or the effect of trees in cooling and cleansing the atmosphere. Ultimately, many of these public benefits can be measured and their dollar values considered in the political calculus of land-use decision making. In the meantime, it is surprising, not that we can measure so little of the benefits from trees, but that the benefits we are able to measure are so large. Consider that if trees contribute 7 percent to property values, in a city of 10,000 homes, for example, with an average value of $30,000 each, the value of the residential trees would be $21 million. □

Eight room French Provincial; appraised value $44,400.

BRIAN R. PAYNE

The Battle of Lynn Woods

by Barry Gordon and Thomas G. Lambrix

Often unrecognized, more often mistreated, the forests within America's metropolises are sanctuaries from the noise, glare, and foul air of the city. These forests, large and small, publicly and privately owned, go unrecognized possibly because they are not supposed to exist within metropolitan areas. They are uncared for partly because they are unnoticed and unappreciated. Also, many of their owners cannot, or choose not to, spend the money required for proper maintenance.

The lack of simple knowledge about the existence of an urban forest is often compounded by public confusion and misapprehension over access routes, facilities available, fees charged, or other entrance constraints. Even when people know about an urban forest, they are often unable to visit it because it is difficult to reach. Children can travel relatively long distances on bicycles or by hitchhiking, but entire families without cars are considerably less mobile. Census figures show that automobiles are not readily available to many residents of large cities. (For 1970, approximately half of the households in the city of Boston reported no available automobile, while some individual areas reported almost 90 percent unavailability.) The inadequacies of many public transportation systems further compound the problem. Thus, for many city families, a forest or wooded park in a nearby area might just as well be a hundred miles away.

Even when lack of information and mobility are not problems, a poor image will act as a deterrent to the use of an urban forest. Litter and vandalism create a reluctance to visit an urban forest, and fear of crime deters people who would otherwise enter a wooded area in search of solitude.

A related obstacle to use occurs when potential visitors perceive a recreation place as belonging to, or controlled by, a group of which they are not a part. This can include ownership by another municipality, frequent use by a particular ethnic or racial group, or territorial occupation of the area by a street gang.

Forests have always been thought of in highly symbolic terms, and this, too, has worked against the use of urban forests. To some people, these forests are not "real," simply because they are not located in a rural area. Yet some metropolitan stands of trees are forestlike. They could accommodate a number of activities, such as hiking, swimming, and tent camping, which people now travel hundreds of miles to enjoy.

Because they are often viewed as little-used and undeveloped spaces, urban forests have frequently been targets for the location of transportation and development projects. Areas that have no extensive recreation facilities or that experience little obvious use are particularly vulnerable because they are thought of as being virtually "useless" by some local residents and government officials.

Conflicts involving proposed highway routes through such public open spaces have been occurring for many years in all parts of the United States. Specific issues have ranged from plans to improve tourist roads in national parks to fights over an acre of public lawn in the heart of a New England city. Its benefits notwithstanding, the Interstate Highway System has become one of the greatest sources of these road/open space conflicts, especially where highways were planned to traverse urban areas in which open space is relatively scarce.

A controversy involving urban open space directs new attention to the area in question and may evoke the expression of otherwise rarely stated feelings about the resource.

One recent conflict between a proposed highway and an urban forest occurred in Boston's North Shore suburbs, and it is not only a relevant example of the decision-making process in such a dispute, but it also emphasizes the general plight of the urban forest. The road in question was an eleven-mile segment of Interstate 95 (the Maine-to-Florida route), and the resource was Lynn Woods, a 2,000-acre, little-developed woodland located primarily in the city of Lynn.

The histories and fortunes of Lynn and its Woods are closely intertwined. The area that was to become Lynn was settled in 1629 by a group of colonists who had left nearby Salem and founded the new community of "Saugust." These settlers, mostly farmers, occupied a two- to three-mile-wide strip of land between the ocean and the wooded hills. In 1637 the town was renamed Lynn, and a year later the first formal division of land was undertaken. The rugged and remote woodlands, part of which are today's Lynn Woods, were reserved as common property. During the seventeenth century changes made in this common area included rock walls for pasture division and deep pits to serve as wolf traps.

Early in Lynn's history the base was laid for the industrial activity that would characterize the city in later centuries. In 1635, the city's first shoemakers set up shop, commencing a manufacturing tradition that made Lynn one of the leading shoe centers in the country well into the twentieth century.

The next major decision affecting the Woods was a second division of land in 1706 in response to increased population and the informal staking of land claims in the forest. This assignment of land to Lynn property owners, however, did not prohibit the common use of the Woods for timber supply and hunting.

As improvements in shoemaking techniques encouraged an increasing number of residents to abandon agriculture and take up the shoe trade, Lynn assumed the character of a city. The significance to the community of Lynn Woods decreased as coal replaced wood as fuel for factories and homes. One historian described this demise in prophetic terms: "So it came to pass that the woodlands were more and more neglected, till, considered worthless, they were forgotten." Near the end of the last century, four reservoirs were constructed in the Woods for the city's water system. The area was designated a free public forest, a few facilities were built, and through the 1940s there was heavy family use.

Lynn Woods, Massachusetts

CARY S. WOLINSKY

At the time of the highway controversy in the 1960s, the general condition of the Woods paralleled that of the city. Both had seen better times in the past. Lynn, now an industrial city of 90,000 people, has in recent years experienced a fate typical of many New England communities: neither population figures nor the number of available jobs has increased. Although the city's tax rate is one of the highest in Massachusetts, the city's financial condition is not rosy. The central business district lies within the shadow of aging, dark brick mill structures, many of which housed the shoe industries, so much a part of the city's history.

The Woods still possess the characteristics of a rural forest rather than that of a developed urban park. Elevations in the Woods are generally one hundred to two hundred feet above the nearby coastal plain, and the glacial topography is typically rugged and diverse. Upland, field, swamp, and pond areas are all present. A large portion of the land is covered by scrub and maturing forest vegetation. Some sections have an understory of thick woody shrubs while others are open space.

Wildlife in the Woods includes small mammals such as raccoons, red and gray squirrels, other rodents, and a few red fox; snakes, frogs, toads, salamanders, and turtles abound in the aquatic habitats; wooded swamps and shallow marshes provide excellent nesting sites for ducks; and the reservoirs serve as transient holding areas for migratory waterfowl. A wide range of land birds can also be sighted in the Woods, and species normally foreign to urban areas, such as the Parula warbler and the crested flycatcher, are present. Among the fish present in the ponds are bass and various panfish. Although fishing is officially prohibited, children can frequently be seen walking home from the ponds with their day's catch.

There are more than a few places in Lynn Woods where it is quite easy for visitors to forget that they are no more than a few miles from the heart of one of the country's larger urban areas, only two miles from Lynn's business and manufacturing districts, and within a single mile of busy, congested U.S. Route 1. Even from elevated vantage points, a hazy day produces the illusion of an unending forest vista.

In recent decades, however, a general decline in family and group-oriented activity in the Woods has occurred, attributable to two conditions that have affected use patterns in urban parks throughout the United States. One of these is the increased mobility of the middle class provided by the automobile: many families, no longer tied to nearby recreation facilities, frequently ignore local areas in favor of more remote rural places. Related patterns, such as increased ownership of power boats and recreational vehicles, have also accompanied a switch from the more passive activities possible in Lynn Woods to more dynamic and travel-oriented pursuits, which are accommodated only in larger, more remote locations.

The other condition that has caused a decline in visits to this urban forest represents one of the major obstacles to any program for making Lynn Woods a place of recreational value for larger numbers of North Shore residents. This is the fear and aversion associated with litter, vandalism, and violent crime. The first two of these are extensive in the Woods, ranging from the ever present beer can to the slow, but systematic, destruction of the various structures within the Woods. Violent crimes against persons are rare; visitors to the Woods are undoubtedly statistically safer there than they are in many other parts of the metropolitan area, which they visit more frequently. Nevertheless, expressions of distaste regarding the litter, and of fear of crime in the Woods, are heard time and again. A pattern of inadequate resources for proper patrol and maintenance, increased deterioration, resultant fear, and less interest in, and pressure for, a cleanup prevailed until recently.

Therefore, when the conflict between the road and the Woods began to develop, the Woods were a deteriorating, relatively little-used resource located on the edge of, and owned by, an aging and somewhat troubled industrial city. The fiscal problems of the city, the neglected condition of the Woods, and fear of using the Woods were issues frequently mentioned as the controversy developed.

The Lynn Woods have long been the object of development plans. As early as the 1920s, local officials suggested the construction of a scenic highway through the Woods as a bypass for traffic to the Lynn beaches. In 1957, a committee of the Greater Lynn Chamber of Commerce recommended rezoning part of the Woods for industrial and "high-priced" residential use in an attempt to attract new industry and its executives to the city. The proposal was never enacted, but opposition to it was based as much on the plan's impracticality as on interest in preserving the Woods.

The most recent and prolonged controversy can be traced to the late 1950s. It centered around a section of Interstate Highway 95, planned to serve both local and interstate functions, that would pass through a part of Lynn Woods.

The later stages of the planning process for Interstate 95 included a considerable amount of citizen participation, perhaps at a level un-

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equaled anywhere else. The early stages, however, were typical of the times, incorporating little consultation with the public.

In the early 1960s Lynn's mayor and council expressed unanimous opposition to the tentative and confidential plan they were allowed to view, apparently because they felt that the proposed routing would not benefit Lynn economically, while it would cause considerable disruption of neighborhoods. For the next decade an air of uncertainty existed regarding the plan. At the time, in concert with the national attitude toward highways, opposition to the road was voiced primarily by people who would lose their homes or businesses to the road; no audible voice asked *whether* the road should be constructed. Accepting the concept of the road, and with Lynn's less-than-bright economic picture in mind, the city hired consultants to devise a plan that might improve the local economic situation. In late 1963, after negotiating with the Massachusetts Department of Public Works, an informal agreement was reached to follow the city's choice of route, which would cut through the eastern portion of the Woods, traverse a section of Breed's Pond and intrude upon two holes of a golf course that had become the most intensively used facility in the Woods since its construction in 1931.

Not only would the highway itself have to be threaded through the area, but there was also the problem of connectors, or access roads. A significant issue developed when the state and city disagreed on the location of one of the connector roads. The city favored a plan that included an interchange near Dungeon Rock and a road over Breed's Pond. The stated intent for this choice was the preservation of residential areas and improved downtown access, but at a public meeting in February, 1964, the expressed consensus of the 1,300 citizens who attended indicated approval of the road corridor but objection to this connector.

The protest over the connector gained momentum as residents of the Pine Hill district, bordering the southeastern portion of the Woods, recognized the threat to their well-maintained neighborhood, as well as to a large adjacent cemetery. They organized to fight the access road, initially working through an existing civic association, but subsequently forming their own Connector Objector Committee. The primary aim of this group was the preservation of their homes and work places; the protection of Lynn Woods was of considerably less significance. Working in opposition to a number of city officials and agencies and downtown business interests, and eventually carrying their fight to the state legislature, the committee succeeded in having plans for this connector abandoned. As is often the case in a locational conflict, the interests of a particular neighborhood or district had been aligned against the combined interests of a prominent part of the larger community.

Planning for the I-95 corridor through Lynn Woods continued in October, 1964, with federal approval. A Boston area firm completed a basic design report for the route a year later. As a reminder of the lack of attention paid to environmental matters only a few years ago, the report made virtually no comment on the potential impact of the highway on bordering natural areas. Relatively major alterations of land forms were described quite casually, and for Lynn Woods concern was directed primarily toward the impact upon the golf course and the ponds.

Having won the battle over the connector, some members of the Connector Objector Committee turned their attention to the main highway. Their twofold interest was explained retrospectively by one of the antihighway leaders:

> Even though we were assured that this connector move was dead, a few of us felt that the only way to be sure was to kill the proposed corridor [I-95]. During the connector fight, we became aware of the devastation which the corridor would create in our city and how much taxable property would be taken, as well as the havoc it would create in Lynn Woods. We also became aware of the political implications involved.

This appears to represent the turning point, signaling the start of what were to become major efforts against routing Interstate 95 through Lynn. This antihighway campaign did not happen in isolation; it was by now paralleled by similar activities elsewhere in the nation and by increasing antihighway protest throughout the Boston metropolitan area. Impetus came from the growing environmental movement.

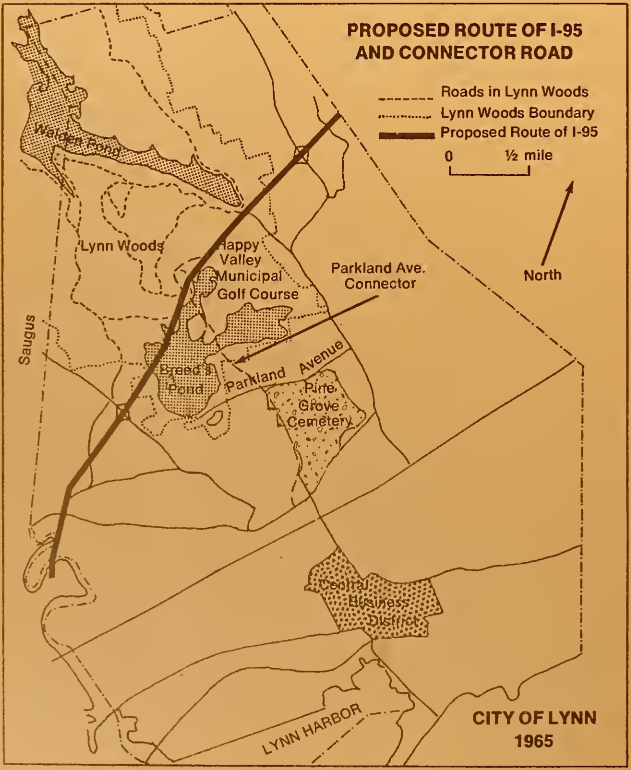
In 1968, a group of citizens formed the Citizens for a Better Lynn (CBL), a small organization dedicated to modifying municipal policy and procedures on a number of matters, including I-95. Since many Lynn residents apparently lacked information about, or interest in, the highway, initial CBL efforts were educational. Initially the inevitability of I-95 was accepted even by CBL, and the committee's efforts centered around the remaining connector roads. At the same time there was growing official and business support for the main road and connectors, and the filling of nearby Saugus Marsh as a base for an adjoining segment seemed to enhance the certainty of construction.

The interests favoring the road had as allies what is commonly referred to as the "highway lobby," ranging from local highway contractors and construction unions to national industry organizations. Local businesses also stood to gain from certain roads and were active in their support.

Toward the end of 1968, a number of antihighway groups merged to form the umbrellalike North Shore Committee on Transportation (NSCOT), and the idea that the road itself could be fought began to gain credence through this alliance. In February, 1970, Gov. Francis W. Sargent placed a moratorium on most road construction within Boston's circumferential highway 128, and NSCOT soon began to assemble its arguments against I-95, stressing the destruction of residential neighborhoods, the intrusion upon open space, and the need for improved public transportation. Some of the long-standing complaints, such as neighborhood disruption, although valid, did not seem useful for winning the desired broad political or legal support. The committee members turned to the related issues of recreation, open space, and "the environment," and here they discovered that Lynn Woods could be a key weapon, because the Woods portion was a central part of I-95 North. The Department of Transportation Act of 1966 required planning "to minimize harm" to such places as Lynn Woods; the Environmental Policy Act of 1969 required the preparation of an impact statement.

At this point, and through the remaining months of the conflict, individuals active in the pro-Woods, antihighway efforts were motivated by various concerns. There were some who were using the Woods only as a tactic to halt the road for other reasons. Others had a specific interest in saving the Woods for personal and community recreational and esthetic purposes. A third group made little or no active use of the Woods but wanted it saved as a matter of principle.

In early June, 1972, Governor Sargent ruled out the Lynn Woods route as being in violation of Section 4(f) of the Department of Transportation Act of 1966, because there existed feasible and prudent alternatives to the taking of parkland. On November 30, 1972, the governor proposed a comprehensive Boston area trans-


PROPOSED ROUTE OF I-95
AND CONNECTOR ROAD
Roads in Lynn Woods
Lynn Woods Boundary
Proposed Route of I-95
0
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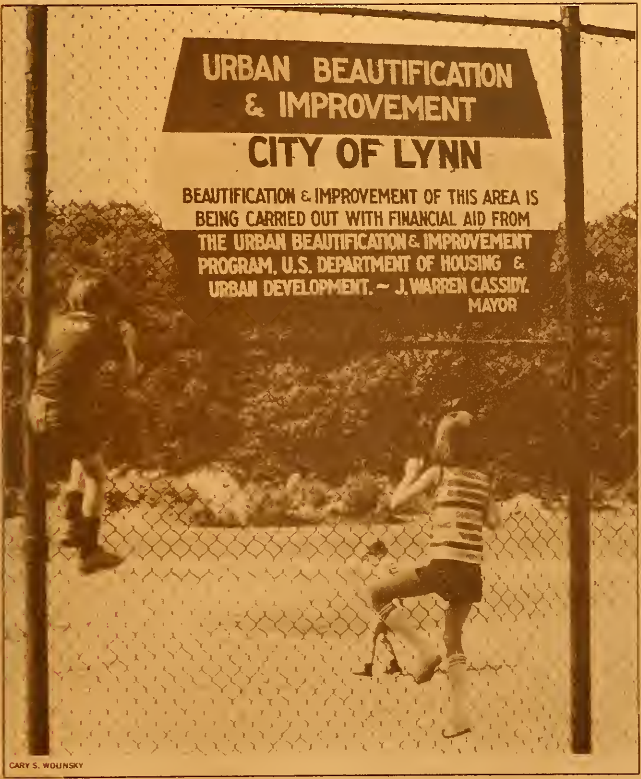
Lynn Woods
Happy Valley Municipal Golf Course
Parkland Ave. Connector
Saugus
Breed's Pond
Parkland Avenue
Pine Grove Cemetery
Central Business District
LYNN HARBOR
CITY OF LYNN
1965

portation plan, one of the major features of which was the fundamental decision to emphasize public transportation over highways. No new I-95 was to be built on the North Shore; instead a major upgrading of existing Route 1 was planned. Thus, pending any major change in plans, Lynn Woods will not be traversed by a highway.

Not all forest areas located within metropolitan boundaries are as large as Lynn Woods, nor do they necessarily have as much historic interest, nor have they all been the center of a recent development controversy. But the issues involved in this controversy touch upon many of the philosophical dichotomies that have characterized the environmental movement.

Often the suggestion that a particular open space area be preserved or developed for other uses leads to a controversy that becomes couched in polar terms. The matter quickly becomes one of "birds vs. people," "disruption of open space vs. destruction of neighborhoods," or "jobs vs. wildlife."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BEAUTIFICATION & IMPROVEMENT OF THIS AREA IS BEING CARRIED OUT WITH FINANCIAL AID FROM THE URBAN BEAUTIFICATION & IMPROVEMENT PROGRAM, U.S. DEPARTMENT OF HOUSING & URBAN DEVELOPMENT. ~ J. WARREN CASSIDY. MAYOR

GARY S. WOLINSKY

One persistent, but incorrect, assumption about urban forests is that nobody uses them. By definition, the uses of woodlands for esthetic and recreational purposes are unorganized, low-key, and rarely apparent to the casual observer. Furthermore, some of the most regular users of urban forests are members of a politically impotent group—children.

There is a good chance that something will finally be done to make Lynn Woods a more favorable place for residents of the Greater Boston area. But there are literally thousands of urban forests, ranging from half-acre patches of woods left standing by a housing developer to large publicly owned forests such as Lynn Woods, which remain neglected, unfamiliar to nearby residents, and considered only as dirty, dangerous, and useless places.

Epilogue

During the summer of 1973, the Lynn City Council overrode two mayoral vetoes of a $3.8 million recreation development and management plan for the city of Lynn. Approximately 75 percent of this amount will be devoted to the improvement of Lynn Woods, including the development of a ski area, a marina for nonpowered boats, stables, a new entrance, improved trails, a nature education center, and general restoration of the Woods. The plan also calls for improved maintenance and supervision. Undoubtedly these changes will alter the character of the Woods, but the forest atmosphere will be preserved in many areas. Implementation of the plan is scheduled for early 1974. □

Return of the Forest

by Paul E. Waggoner and George R. Stephens

Three centuries ago European colonists beat back the forest from enough acres of eastern America to grow crops; when the farmers and traders became prosperous, cities grew in the cleared land. But about a century ago the need for cropland near the eastern cities began to decline because trains were bringing food from the more fertile lands to the west, and modern agriculture was producing more food from fewer acres. The son of the eastern farmer went west or found a job in a factory; his grandson found a job in an office; and the forest—which had not been completely eradicated—began to infiltrate untilled fields and ungrazed pastures.

Today, the squads of trees in many metropolitan wooded areas are skirmishers of a vaster army that seemed to retreat for a couple of centuries but now advances in the fields outside the central cities. The suburbanites and their lawnmowers, together with the builders and their tractors, are not holding back the forest as did the farmers with their axes, plows, and livestock. A succession of trees is spreading from the fencerows and woodlots into the abandoned fields and creating suburban forests.

This process has created more wooded acreage in the Mid-Atlantic and New England states than had existed at the close of the Civil War—despite the megalopolitan sprawl that extends from Boston, Massachusetts, to Washington, D.C.

The course of the reoccupation by a succession of trees, proceeds somewhat differently on a ridge and in a meadow and somewhat differently in New England and in Georgia. The process in Connecticut is illuminating, for the state lies in the heart of an urbanizing region; and the birches of Robert Frost's poems, red cedar characteristic of Virginia, and tulip poplar from the southern tree family, *Magnoliaceae*, all appear in Connecticut's forests.

The farmer's abandonment of the land facilitates the first step in the forest's reoccupation. All deserted fields do not become lawns. In a recent decade agriculture lost about 125,000 acres in Connecticut, but only about half went into home or industrial building. The remainder reverted to forest. A century of these changes has converted Connecticut into a state that is simultaneously suburban and forested. A cursory glance may suggest that New York's northeastern neighbor is made up primarily of stops on the railroad, factories that make metallic things, and the home offices of insurance companies, but in fact Connecticut is two-thirds wooded, and half of that is less than 100 years old.

As soon as the plow and cow leave, the forest pioneers fly in. The light seeds of the birches and aspen blow in from any nearby stands, and the heavy seeds of red cedar and black cherry arrive via birds. These pioneers begin to colonize any abandoned field, and if they are mown down, soon pop up again. Finally, when the mower tires, the plants take firm hold, and succession begins in earnest. It proceeds slowly, but rapidly enough so that between childhood and adulthood you can see an old pasture become a thicket. Then a prolonged fight for survival sets in among the many hundred plants per acre to decide which will make the forest that succeeds the thicket.

Until the early part of this century, foresters were far from certain what course succession would take after the appearance of the thicket stage. In 1927 the Connecticut Agricultural Experiment Station set up a study that would eventually reveal the stages of succession in the suburban forest. Transects through four tracts of land near the Connecticut River in the vicinity of the eastern highlands of the state were established, and every plant with a stem thicker than one-half inch was identified. At that stage, the plots contained an average of 1,500 stems and 37 species per acre. Red maple, blue beech, white oak, black birch, and witch hazel were the predominant species.

Encompassed within the plots were old forest, which had never been tilled but which had lost its dominant American chestnut to blight; forest that had been grazed and burned; and new forest that had arisen on fields tilled by a past farmer. A bench mark was thus established in forests that were beyond the thicket stage, and if foresters kept the faith, preserving the plots from man-made disturbance and coming back to count the trees, they could learn the natural succession in the mixed hardwood forests that surround many eastern cities.

In 1937, 1957, and 1967 the old maps were taken from the cupboards and tree growth and death and new arrivals in the forest were recorded.

In a botanical version of the adage that the rich get richer and the poor get poorer, the percentage of trees large enough to be called poles, or saw timber, increased from 9 percent in 1927 to 30 percent in 1967 in an average acre, while the total tree population per acre fell from 1,500 to 600 trees. The number of species, however, scarcely declined in 40 years, and only quaking aspen, butternut, red cedar, and black cherry disappeared from the original list of 37 species. The thicket is still botanically diverse.

A fire on one of the tracts in 1932 arrested the succession and, in an instant, turned time back three decades. But the phoenix of the new forest rose, little changed, from the ashes. The treeless state of old field or clear-cut forest was not achieved because the fire killed mainly small trees, and three and a half decades later the forest was again a mixture of young and old trees. Twenty-five years was long enough for restocking and recovery, and perhaps because fire was historically common in the area, the 1932 conflagration scarcely changed the composition of the forest.

The forest landscape, the view of the woods from far away, is the canopy. These tall trees absorb the greatest portion of the life-giving sunlight, and during the first three decades of the survey, the canopy was increasingly dominated by oak. During the fourth decade, however, maple, birch, ash, and the tulip tree increased their role in the dominant stratum of the forest, adding their colors and textures to the visual richness of the landscape.

The fourth decade was one of drought and defoliation by gypsy moths and cankerworms. A comparison of the dry decade with earlier ones on tracts that were not defoliated revealed no significant effects from the drought. Defoliation, however, particularly severe on the oaks, did influence the forest: where the trees were defoliated, the growth of the major species was at least halved, while the minor species, benefiting from the several weeks of sunlight reaching them through the barren branches of the larger trees, grew faster.

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As more people have migrated into the suburban forest public concern has increased over defoliation of the forest by insects, particularly the gypsy moth. There have been strong pressures for pesticide spraying. Observations made in the affected plots for more than a decade revealed that a single defoliation did not increase tree mortality. But repeated defoliation doubled the mortality during a decade. Death was more frequent among oaks—the favorite food of several defoliators—than among maples or birches. This is one reason why the oaks have lost some of their dominance of the upper story of the forest.

The observations covering a period of more than 40 years have shown that an abandoned field is quickly invaded by such pioneer trees as junipers and birches, that within a decade a thicket has formed, and that a forest of a few hundred trees per acre eventually transforms the land into a wooded landscape. The composition of this forest differs from the thicket of 20 to 30 years previous only in the loss of a few pioneer species.

The forest, once beaten back from much of the east, has been advancing back into the metropolitan belt for more than a hundred years. Covering old corn fields and pastures, re-covering woods decimated by fire and disease, the process of natural succession is providing our children with a forest landscape richer than the one our fathers and grandfathers enjoyed. □

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Barry Gordon, a geographer with the United States Forest Service, is currently in residence at Syracuse University, where he is doing research on people's attitudes toward the forest environment. **Thomas G. Lambrix** is an outdoor recreation planner with the United States Department of the Interior. He is studying the problems of open space recreation in urban areas.

Paul E. Waggoner, director of the Connecticut Agricultural Experiment Station, is conducting mathematical analyses of the different stages of natural succession and the distributional patterns of plant diseases. **George R. Stephens**, a forester at the station, is investigating the effects of insect defoliation on trees. □

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The turkey has been associated with Thanksgiving since the Pilgrims served four wild turkeys at their first harvest dinner. Ironically, it was the arrival of the European settler in North America that marked the beginning of the wild turkey's decline. Because its habitat interfered with man's agrarian interests, the turkey, more than most other native game birds, suffered from the advance of frontier civilization. As the forests were systematically logged, burned, and converted to farmland, the turkey's range was reduced to one-tenth its original size. Extirpated from its toehold in southern Canada and from nearly half of the thirty-nine states it originally inhabited, its total numbers dropped to critical levels. Yet today, despite an expanding human population that continues to encroach on its habitat, the turkey has not only been restored to most of its original territory, but it has also been successfully established in several western states beyond the limits of its historical range.

Largest of the gallinaceous game birds, the turkey (*Meleagris gallopavo*) dates back to the upper Pliocene. There is no direct evidence that it ever occurred beyond where it lived in historic times in North America: from Maine to Florida, southern Ontario to southern Mexico, and Wisconsin to Arizona. Since this broad distribution crossed a diversity of habitat types, six distinguishable subspecies of turkey evolved. The physiological

Turkey Renaissance

In second-growth forests, a splendid native bird gets a second chance

by Gerald A. Wunz and Arnold H. Hayden

differences between these subspecies are so great that generally one cannot survive in another's habitat. Those in eastern forests are darker plumaged than western subspecies, which inhabit a bright environment. In addition to color and physiology, there are differences in temperament and behavior.

The adjective *wild* does more than distinguish the forest inhabitant from the barnyard type, which originates from a Mexican subspecies that was first tamed by the Aztecs, then taken to Europe by the early Spanish conquistadors, and finally brought back to the New World by later American colonists. Because of controlled breeding today's domestic turkey cannot survive without man's protection. *Wild* also indicates that the turkey is extremely wary. The bird has excellent eyesight and seems capable of immediately sorting out perceived images. We have seen turkeys ignore deer, bears, and even foxes, but if an approaching animal resembles a human, they flee on powerful legs at speeds of up to 25 miles per hour. If startled, a 20-pound gobbler, with a five-foot wingspread, can flush like a grouse, thrash through a maze of treetops, and glide on set wings at 50 miles per hour for a mile or more.

JOSEPH VAN WORMER—BRUCE COLEMAN, INC.

Throughout history, each race of the wild turkey withstood the elements, animal predators, and even the primitive hunting tools of the Indians. But they could not tolerate the inroads of the European colonist. By 1900 the turkey population had declined drastically; then a heightened public awareness of conservation needs reversed the trend. Today turkeys inhabit 42 states, and their numbers continue to grow.

The wild turkey's comeback can be attributed partly to its tenacity and adaptability and partly to the efforts of conservationists, who worked to see that the bird did not go the way of the heath hen. In state after state the re-establishment pattern has been much the same—we will use Pennsylvania's experience since we are most familiar with it.

As early as 1873 Pennsylvania had enacted legislation to prevent market hunting and control the annual turkey kill, but strict enforcement of these laws came only after the establishment of the Pennsylvania Game Commission in 1896. To further protect the dwindling turkey population, which had retreated to the south-central mountains, game lands were purchased and refuges established in key areas. Thus, remnant flocks were saved and the turkeys began to increase. But because most of their former range in the lowlands of the west and east sectors of this heavily populated and industrialized state were now farmed or urbanized, there was a limit to how far they could spread.

It was then that a hopeful eye was cast on the Allegheny Plateau, a vast area of north-central Pennsylvania. Historically, the region was forested with conifers and harbored no turkeys, but at the turn of the century, massive clear-cutting occurred on the plateau, followed by brush fires and excessive browsing by proliferating deer herds. The result was a new type of forest environment—the virgin pine and hemlock were replaced by deciduous, broad-leafed northern hardwoods, primarily beech, birch, maple, cherry, ash, and some red oak.

In 1930, the State Game Commission started a game farm to artificially propagate turkeys from semiwild breeders, but the resultant progeny were too tame to adapt to an unprotected wild environment. Placing the hens in open-top pens where wild gobblers could fly in and mate with them produced somewhat wilder hybrid offspring. These were stocked in the new hardwood forests on the Allegheny Plateau, but the initial results were so poor that we concluded that oaks—scarce on the plateau—must be essential to turkey habitat.

By 1940, however, a few flocks were noted north of the west branch of the Susquehanna River. Then the birds began to invade the northern hardwood forest, encouraging further releases of game farm turkeys. The turkey populations peaked as flocks filled the vacuum and advanced their range about five miles per year through northern Pennsylvania and western New York. By the late 1950s all of this contiguous forest was inhabited by turkeys.

At the time, we naturally attributed this restoration success to the stocking of artificially propagated turkeys. But when this stock was released in other sections of Pennsylvania, and in other states as well, few lasting populations developed. A 16-year restoration evaluation study in Pennsylvania finally revealed that game farm turkeys could not establish flocks in any but the most protective of environments; furthermore, stocking game farm birds in occupied range often caused declines in native turkey populations. Not only did game farm turkeys carry disease and parasites, but there were also indications that when pen-raised stock mixed with wild flocks, the offspring carried traits for tameness that jeopardized their survival.

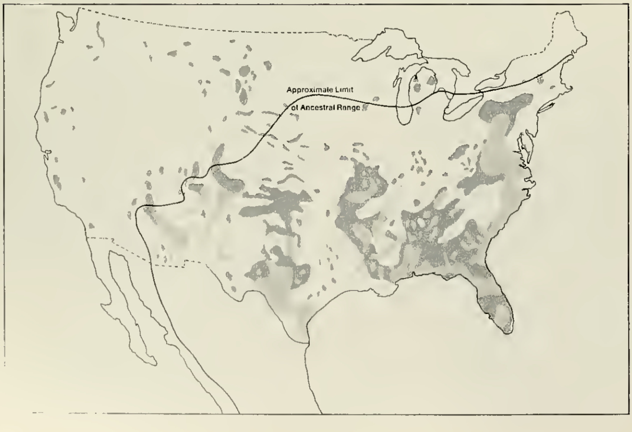
There was further evidence that the northward spread of turkeys was due mostly to native flocks emigrating from the south-central mountains and not to the successful adaptation of game farm stock. Over the years, thousands of artificially propagated birds had been stocked in habitat units isolated from the contiguous central Pennsylvania range, but in a follow-up search few turkeys were found in these units; spread had occurred only where native wild birds were unimpeded by urban and agricultural barriers, not where game farm birds had been stocked.

Why did pen-raised birds fail to establish lasting flocks in the wild? Why did so many poults raised by game farm hens die before one year? Put simply, game farm turkeys were not wild enough; they were incapable of learning to avoid predation, and annual replenishment failed to offset attrition.

Other states have reported similar results. New York's Catskill flock grew to moderate levels, but never reverted to a truly wild temperament and was in danger of extirpation until wild-trapped birds were stocked in the area. Reports from Massachusetts's Berkshire flock were the same.

While northern states were still experimenting with game farm turkeys, most southern and western states had given up on this hybrid stock and instead were successfully establishing trapped and transferred native flocks, even in areas where poaching had been a problem. These live-capturing programs are responsible for the turkey's spectacular comeback—in the past two decades its population has nearly tripled and now numbers more than 1.25 million birds. Texas boasts a population of nearly 600,000 Rio Grande turkeys, while Alabama claims nearly half that many eastern turkeys. In Vermont, 31 live-trapped birds, imported from western New York only three years ago, grew to an estimated flock of 500. Because of the increase in wild turkey population, thirty-six states now permit hunting.

It is expected that transferred wild turkey stock will eventually establish turkey flocks in nearly every state. The turkey is an adaptable bird, but we must still pay attention to the type of subspecies stocked. Game farm turkeys, for example, have done poorly in nearly all states except Michigan and Wisconsin, and we wonder if wild stock would have done a better job in establishing turkeys in those states as well. The Merriam turkey, a native of the mountains of the Southwest, has been transplanted widely and successfully in all western states, wherever an isolated ponderosa-pine-covered upland juts up from the desert lowlands that were barriers to the birds' natural spread. In Michigan, as in northern Pennsylvania, where conifer forest succeeded to broad-leafed hardwoods, turkeys were moved north of their ancestral range. They have been successfully introduced into California from Texas, but these same birds failed when transferred to east



Turkey distribution in 1973 (dark areas) indicates expansion since 1943 (light areas). Turkeys are now found beyond the limits of their ancestral range.

Like most male birds, the wild turkey gobbler is showier than the female. The brilliant coloration on his head and neck becomes more intense during displays.

KIRTLEY-PERKINS,
NATIONAL AUDUBON SOCIETY

Texas, where the annual rainfall exceeds the critical maximum of 30 inches for the Rio Grande subspecies.

For the time being, the turkey has been saved from extinction and will soon be established wherever there is suitable habitat. But habitat and populations are not static, and to save the turkey for perpetuity, we needed to know more about the bird and its environment. Although much folklore had accumulated around the turkey, biologists could not fully explore the life history of this shy bird until the recent development of biotelemetry equipment, which allows periodic monitoring of an animal's whereabouts via a back-

GERALD A. WUNZ

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Building nests in brushy cover, female turkeys, above, incubate the speckled eggs for 28 days. At three weeks of age the poults, top, although still small, are able to fly and will retreat to a tree to escape wildcats, foxes, and other predators. A gobbler, right, strides across a clearing. His long "beard," unique to turkeys, indicates that he is at least three years old.

pack miniature radio transmitter. Our descriptions of turkey behavior and life history, based on observations of northeastern birds, generally apply to other subspecies as well.

The mating season begins in the spring. A dominant male turkey establishes a territory—undefined and subject to change depending on the availability of hens—then begins his dramatic courtship display. With his tail fanned erect and his head and neck showing bright red, white, and blue, the male struts and gobbles to attract a hen. Eventually he acquires a harem of several hens, which he isolates from other toms. After mating, the hens steal away to lay their eggs, usually choosing brushy cover in the forest. The nest is a slight depression in the ground, where, over a period of two weeks, the female lays an average clutch of twelve speckled beige eggs. The tom takes no part in incubation or brood rearing; after mating, he roams alone or with other gobblers.

If the nest is not covered by spring snowstorms, destroyed by predators (a raccoon, skunk, or opossum), or deserted because of human disturbance, the eggs hatch in late May or early June after incubating for 28 days. A chilling rain after hatching can kill the poults, but because all hens do not nest at the same time, some poults are sure to survive. Hens whose clutches are destroyed usually renest; those that lose their broods, however, do not nest again.

As soon as the down dries on the precocious poults and they are rested from picking their way out of the shell, they begin almost incessant feeding. The hens move their broods out of the forest into clearings, glades, or savannas, where they can find a growth of grass and other herbaceous plants, usually near a spring seep or other source of water. These open areas also abound in insects and small invertebrates, which make up a large proportion of a poult's diet during the early weeks of its life.

Because the young are now most

GERALD A. WUNZ

TIONAL AUDUBON SOCIETY

vulnerable to both winged and ground predators, the hen turkey is constantly alert. In the face of danger, the young hide while the mother lures the intruder away by feigning injury. From a safe distance she will periodically cluck to keep the poults from moving, but if they emit a distress call, she will threaten and, on occasion, attack the intruder. When they are two weeks old, the poults are able to fly, and an alarm call from the hen will induce them to scatter into the shrubs and lower limbs of trees to escape. From that time on, they will roost in trees at night.

As the poults grow larger, the brood's mobility increases. Usually several broods in an area combine to form a larger flock, sometimes numbering as many as fifty birds. There are frequent shifts in habitat as the availability of food changes. Late in the summer the broods still feed on ripening grass seeds, berries, mushrooms, and insects found along the edges of clearings. During autumn flocks begin to stray into the forest where they feed on seeds and the nuts of such trees as oak, beech, cherry, ash, dogwood, and ironwood. If there is a poor crop of mast, turkeys scratch into the forest humus to obtain tubers and bulbs. They also eat the sporeheads of ground pine and princess pine during years of mast scarcity.

The poults grow quickly; by November a young hen weighs six to eight pounds and a tom ten to thirteen pounds. Growth slows the second year, until the birds reach their maximum weight of nine to ten pounds for hens and eighteen to twenty-four pounds for gobblers.

With the arrival of winter, there is less food available, and the flocks again split into smaller groups. The young toms form bachelor flocks, while adult toms stay in the small flocks they formed after the mating season or in solitude. Each flock develops a social hierarchy with a leader and a pecking order.

Turkeys are wide-ranging during the fall when they may roam over several thousand acres, but as winter snow accumulates, their mobility is restricted to as little as 10 percent of the total available range. They respond to the reduced food supply and opportunity to feed by lessening activity to conserve body weight. During a severe snowstorm a bird may spend a week or even longer in a roost tree. Our experiments have shown that turkeys can live without food for two weeks, after which, despite a 40 percent weight loss, they can recover and even gain weight on reduced food rations. After two weeks of inactivity on the roost, however, turkeys fall from exhaustion, their fat and tissue reserves depleted.

Fortunately, severe winters do not occur often in wild turkey range. Winter losses are largely confined to high mountains and plateaus, which most turkeys forsake for lower or south-facing slopes and valley bottoms when snows begin to deepen. Here they roost in wind-deflecting conifer groves, forage for plant and animal life in spring seeps that remain free of snow, feed on sensitive fern sporeheads, pick beech buds, and glean any remaining conventional foods. Winter foods such as fern sporeheads were once thought of as a starvation diet, but nutritional analysis has shown them to surpass corn in food value. Turkeys are omnivorous opportunists, and starvation is unlikely as long as a bird has firm footing to travel and feed. Even in the worst winters many survive, and the hardship actually seems to stimulate reproduction the following spring.

With its numbers growing and its range expanding, the turkey's future, like its past, will continue to be intimately connected with man's. As marginal farmland is abandoned in eastern turkey range, new growth—initially shrubs and thickets—moves in, providing the varied habitat turkeys need. But expanding urban areas, highways, and new recreation uses of forests, such as snowmobiling, could adversely affect turkey numbers.

Successional changes within forests themselves are also important. As conifer forests are logged out and deciduous trees take their place, turkeys fill the new niches. Conversely, turkey populations are declining in the south, where the logging industry is converting hardwood stands to short-rotation pine. Also in the south, real estate development is threatening the Florida subspecies, while the Rio Grande turkey's habitat is endangered by stream channelization and pasture improvement projects.

As we learn more about the turkey and its habitat, some of our conceptions of its range requirements are changing. Turkeys had always been considered a species of the semiwilderness, requiring a range of at least 15,000 acres and a minimum of human activity. But this notion arose years ago in an era of rampant poaching.

We decided to find out just how small an area and how much disturbance turkeys can tolerate. We stocked small groups of wild-trapped turkeys on three marginal habitat areas in and near urban regions of western Pennsylvania; the areas varied in amounts of available range and human activity. In two less restricted areas, turkeys reproduced and increased.

Surprisingly, in the most restricted area, Presque Isle, a small peninsular state park on Lake Erie, which receives four million visits annually, the birds also showed amazing ability to survive and adapt. Heavy recreational use confines the turkeys to fewer than 300 acres of the 2,000-acre park, but they are rarely seen by the human visitors. For seven years, they have survived at their threshold of tolerance, just offsetting attrition by reproduction.

Our study raises hopes that the turkey's range can be further expanded into marginal habitat. Having adapted to human presence, survived in smaller areas than ever thought possible, and expanded its range even in the populous northeastern states, the turkey appears to have a bright future. ☐

With its tail spread in a wide fan and its wings scraping the ground, a male displays to attract hens to his harem and to threaten other toms.

Bedouins of the Oil Fields

by Donald P. Cole

Soon after Saudi Arabia discovered oil in its deserts, nomads discovered the versatile pickup truck

Nomadism in the Middle East has until recently represented a successful and efficient adaptation to the ecology of arid and semiarid lands. Moving with their entire families, nomads can leave their summer camps located around permanent water sources and take herds of sheep, goats, and camels wherever the desert blooms. The slight winter rains, insufficient for agriculture but enough to sustain a variety of desert plants, fall in different locations from year to year. Consequently, a good grazing area one winter may be desolate the next, while a nearby area flourishes under greater rainfall.

Animals are the basis of the nomads' livelihood and wealth. They are the source of the milk and milk products that are the staples of the nomad diet. Sheep and camels provide wool for sale in markets and for weaving carpets. From the hair of goats, nomads weave the black tents in which they live. And in an average year nomads also raise a surplus of animals, which they sell.

In exchange for animals, they receive basic necessities from the towns and villages. Their herds of animals and the ability to acquire necessities often make their standard of living higher than that of the traditional village farmer. From a historical perspective, the nomad's status in the social hierarchy has always been high. Today the Bedouins—the predominant Arab nomads of the southeastern portion of the Middle East—sustain their high status by close associations with traditional elites, such as the ruling families of Jordan, Saudi Arabia, and the United Arab Emirates of the Arabian Gulf.

photographs by Tor Eigeland

Through the discovery and exploitation of vast oil resources, Saudi Arabia and Libya—with some of the most highly nomadic populations in the Arab world—have experienced far-reaching revolutions in their economies within the last three decades. As a result, changes are occurring at every level of society. Once among the poorest of Middle Eastern countries, they now boast modern cities, which stand where small mud-brick towns stood no more than two decades ago. Hospitals and schools are common, and the markets of all the major cities sell goods from all parts of the world. Isolated villages are being transformed, as schools, modern water facilities, and electricity are established.

But what of the Bedouins? They still spend long periods each year in the desert. Always on the move, their social units contract and expand throughout the year in response to variations in the environment and the demands of their herds. Hospitals and doctors are nonexistent on the desert ranges, and Bedouins suffer from the highest rate of infant mortality in the Middle East.

To most educated Middle Easterners, the Bedouins are a backward, uneducated, and fanatical element of society, living in a state of misery. They do not admire the Bedouins' ability to endure the vast reaches of the desert, subsisting only on the milk of a few camels and some dried dates.

Modern Middle Easterners, including government officials, feel that the nomadic way of life is an evolutionary state that preceded sedentary life and should therefore be abandoned. Most evidence, however, indicates that pastoral nomads, taking advantage of the pasture lands of the steppe and semideserts, evolved in the Middle East and Central Asia after the development of sedentary agriculture 5,000 years ago during the Neolithic period.

Many Middle Eastern government officials altruistically observe that nomads, along with sedentary villagers and urban dwellers, have the right to modern education, health, and social services; that they should not have to suffer the hot winds and sandstorms of the desert or the insecurity of depending on meager and varying rainfall for the survival of their herds while the majority of the population enjoy increasing comfort and a higher standard of living.

The nomads themselves have initiated many changes on their own, but the problems of adapting a way of life that has remained unchanged for at least five millennia are too complex for easy solutions.

Government-sponsored agricultural sedentation projects designed to aid the Bedouins have been initiated in Middle Eastern countries with significant nomadic populations. The most ambitious and expensive project has been carried out in eastern Saudi Arabia at the King Faisal Settlement Project at Haradh. Here some 8,000 acres of desert have been turned into a lush green oasis with modern wells and technical facilities.

But the government now faces the dilemma of deciding whether this now valuable agricultural land should be turned over to Bedouin nomads who know next to nothing about sedentary agriculture or to large farming interests who could make the land productive for the society as a whole. Some government administrators think the land would not be fully utilized by the Bedouins for at least a generation. Many Bedouins are at best only halfheartedly interested in full-scale sedentation. The dilemma becomes more complex when one considers the number of highly skilled and land-hungry peasants from other oases who would readily participate in the project.

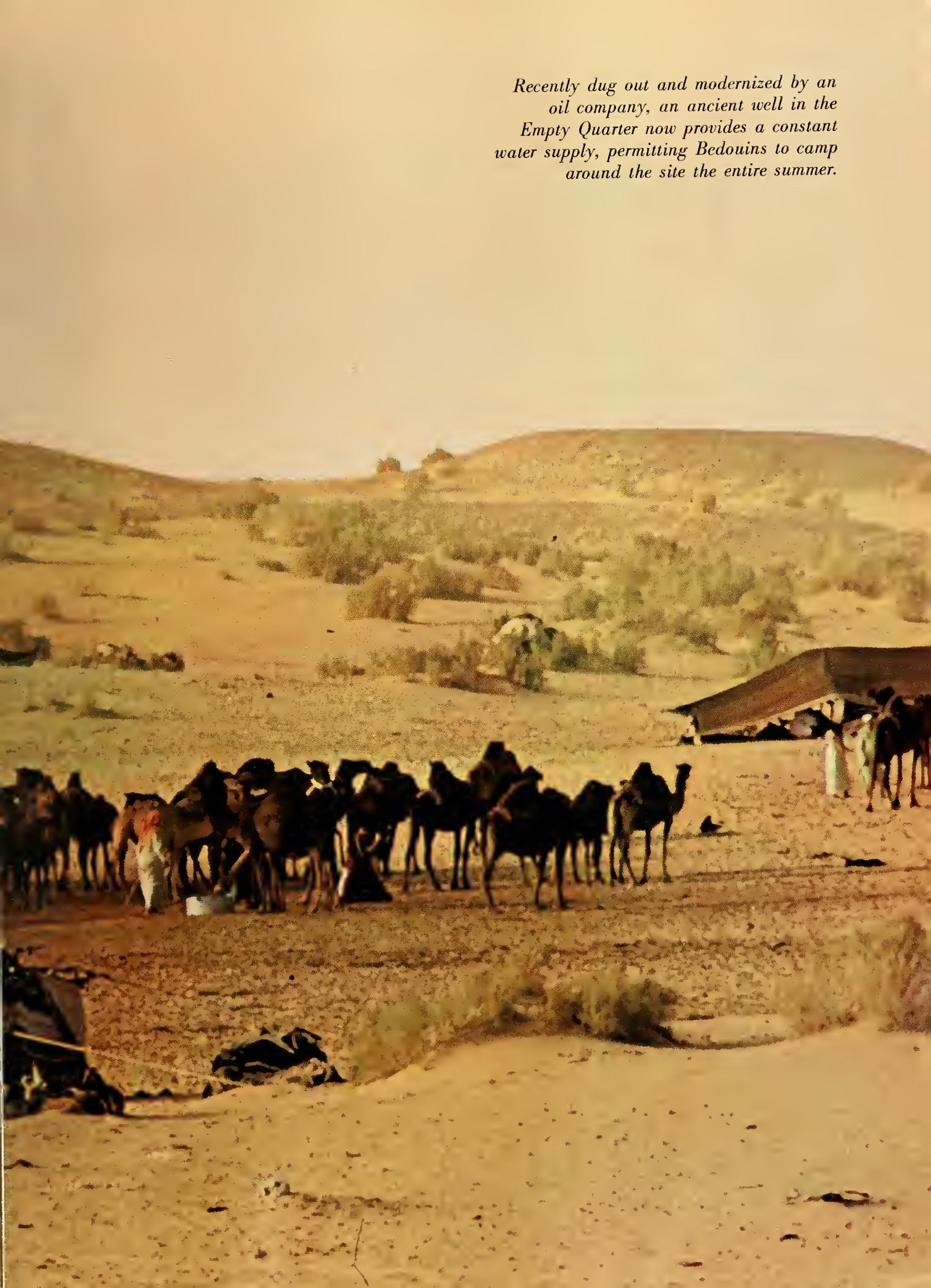
Since new agricultural settlements are ultimately limited owing to lack of sufficient water resources, other solutions must be found to the problem of incorporating the nomads into the modern economy. Some suggest that, as industrialization continues, the nomads, along with most peasant villagers, will eventually enter the industrial labor pool. The Bedouins have for a long time been involved with the oil companies, but industrialization is still in its early stages in most Middle Eastern countries, and the townspeople, having a big jump on the Bedouins in education, are likely to take the best jobs in a developing industrial economy.

One solution that is seldom seriously considered is that of encouraging the modernization of the nomads' economy. The desert is still a major natural resource in the Middle East, and its grasses and shrubs are capable of supporting large herds of animals. Since the time of the late Neolithic when these arid pastures attracted herdsmen away from the agricultural centers of the Middle East, the nomads have become skilled pastoralists adept at utilizing a difficult but productive environment.

The Bedouins are deeply attached both to their animals and to their life in the desert. I have heard many Bedouins argue that their long-time survival will depend on their not abandoning the desert and their herds. They question agricultural experts' estimates that water will continue to be available for at least the next 100 years, a short span of time in their own history of survival. They also wonder how long oil reserves can produce the income needed to import food from the settlements for the rapidly growing cities. Still they are not entirely content to remain isolated and unchanged in the desert.

In the early days of oil exploration in the late 1930s, Bedouins began to work first as guides for the American oil companies in eastern Arabia and then, as unskilled laborers. Because of a lack of skilled laborers among native Saudi Arabians, the Arabian American Oil Company (Aramco) set up special schools for their laborers, a large proportion of whom were young Bedouins, and trained them to, among other things, drive and maintain trucks. Many nomads purchased second-hand pickup trucks

Bedouin children, even the very young, spend much of their time caring for camels and sheep.



Recently dug out and modernized by an oil company, an ancient well in the Empty Quarter now provides a constant water supply, permitting Bedouins to camp around the site the entire summer.

from Aramco and used them to herd their animals in the desert. Later on, in central and western Saudi Arabia, the government distributed large numbers of trucks to other Bedouins. In time, still other Bedouins sold their baggage camels and bought trucks. Pickup trucks have without a doubt had a great effect on the life of the Bedouins.

The increasing use of trucks in the desert has been accompanied by other important changes in the infrastructure basic to the exploitation of the desert. The oil industry developed underground water resources by drilling deep wells, a practice that has been continued and expanded by the Saudi Arabian government. As a result, the nomads' summer camping patterns have been considerably altered. Although the Bedouins dug some wells that were deep and nicely lined, they depended for the most part on shallow, primitive wells that necessitated the backbreaking drawing of water. Today many Bedouins camp around special troughs that have been provided for them near the oil wells, along the pipelines, and at various other spots in the desert.

In these instances, summer camping is no longer based primarily on lineage or clan affiliation, as under the traditional system. Indeed, people from not only different lineages but also from different tribes share new sources of water without the conflict often evident at the old wells. The nomads feel that since the new wells were built by outsiders, they should be open to all comers.

Many small settlements, occasionally incorporating agriculture, have developed around well sites. These settlements consist of mosques, primary schools, and one or two general stores, which sell gasoline, automotive parts, and basic food and clothing. Many of the new settlements include mud-brick houses, which the Bedouins inhabit during the hot summer months and use as storehouses during the rest of the year when they are in the nearby desert with their herds.

The use of trucks and the devel-

Al Murrah camel herdsmen drink coffee in the shelter of a goat hair tent. Their loosely fitted, heavy clothing keeps them comfortable by soaking up perspiration and allowing air to circulate. Even in the 125 degree heat, children are at play.

opment of service towns and modern water resources have allowed the Bedouins to make major changes in their herding practices. Whereas camel herding was the predominant pastoral activity of Saudi Arabia's major Bedouin tribes until the end of World War II, sheepherding has now become the major pastoral concern of many of these nomads. Before desert facilities were modernized, sheep and goat herding, often the exclusive occupation of subservient tribes, was a sign of poverty and low status. Now those who maintain large herds of sheep and who also keep some goats for their household needs are among the richest and most influential nomads.

The Al Murrah Bedouin tribe, among whom I did social anthropological field work, is one of the dwindling number of Saudi Arabian Bedouin tribes that continue to depend chiefly on camels for their subsistence. This traditional occupation is influenced mainly by the highly isolated area they occupy, the Rub' al-Khali, or Empty Quarter, the vast sand desert in southeastern Arabia. Because of the sparse vegetation, camels, capable of easily moving over large distances and of surviving without water for long periods, are more suited to this area than sheep.

In spite of their preoccupation with camels, two important groups within the Al Murrah society have switched to sheepherding exclusively. One is drawn from the tribal political elite and includes a large proportion of the wealthiest and politically most influential people in the pre-oil-industry society. The other group is composed of impoverished nomads who had poor herds of camels. None of the Al Murrah who had herds of purebred camels, other than some of the elite, have switched to modern sheepherding, although camel herding is declining as a major activity among most other Saudi Arabian tribes.

In Saudi Arabia, sheepherding, whether of the modern or traditional type, is a much more sedentary activity and involves much less labor than camel herding. It re-

quires, nevertheless, a certain amount of nomadic movement in order to graze those areas that in any given year have received rainfall. In the past, sheepherding was severely limited because of lack of water in the desert.

With the development of new water resources and with the nomads' ability to truck water directly to the herds and even to move herds to new grazing areas by truck, the potential for sheepherding has greatly increased. Much less demanding and requiring much less movement than camel herding, sheepherding allows both men and women to participate in activities not permitted to camel herders. It also provides greater cash income because of the increasing demands for mutton in Saudi Arabia's growing cities.

Among the tribal elites who have either sold their camels or entrusted them to the care of tribal relatives and switched to sheep, the herding of animals is primarily the work of hired shepherds. The women of the elite families, however, are actively involved in caring for the sheep and goats and processing their products. The men and youths are free to engage in tribal politics, to participate in the Saudi Arabian National Guard, and to seek wage labor.

The nonelitists of the Al Murrah tribe who have switched to sheepherding were and are the social equals of the present-day camel herders, although their camels were often not as numerous or as fine as those of the nomads who continue to raise them. The areas they inhabit are closer to urban centers than those of the camel herders, and they have been more regularly involved in the military and political activities of their tribal leaders and of the Al Saud royal family. As a result, they have been more influenced by the changes emanating from the cities and the oil companies.

In a traditional welcoming ceremony, a Bedouin sniffs incense from a brass-studded container. He uses his head cloth as a shield in order to concentrate the smoke.

Most of the middle-aged men of the nonelitist group have worked for the oil companies or have had some permanent wage-earning contact with urban centers. Many of them, in fact, combine sheepherding with a job or with desert hauling for hire. When they are not working, they truck their sheep to different grazing areas. Their herds are smaller than those of the elitist families and of comparable groups from other tribes who have been in the business longer. With most of the middle-aged and young men off either working or studying, the women and children tend the sheep. Because herding with trucks is less time consuming, the women have more time to weave and create crafts, which are sold in the urban markets.

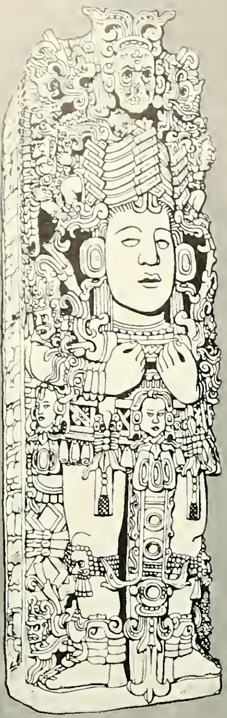
The shift to sheepherding is inevitably accompanied by changes in social structure. Fewer people are involved; some families have become at least semisettled in villages, while an increasing number of males have drifted off to cities and oil camps in search of work. For those who remain actively involved in pastoral nomadism, change occurs mainly at the level of the lineage. There is a break in its solidarity since camels and sheep are seldom herded together. When a man switches to sheep, he ceases to migrate with his far-traveling, camel-herding kinsmen. He sometimes returns to the same summer camping areas, but as often as not, he camps at the newer, modern wells, which he shares with other tribesmen. He is unlikely to see his camel-herding kinsmen except when they chance to meet in urban marketplaces or when they participate in National Guard activities.

He also begins to think of his camel-herding kinsmen as a group apart, and a bit old-fashioned. Although intermarriage is seldom affected and other duties of lineage membership, such as responsibility in blood debts, continue, new informal relationships are built up with members of other lineages and even other tribes.

The basic structure of the household, however, is not drastically affected. While it is true that a large portion of the men and youths are often away from the household, this does not necessarily represent a break in the structure of the family. The women in Saudi Arabian tribes have always been the core element of household and herding units, and large proportions of the males have always gone away from these units, often for long periods of time.

In the past, raids against other tribes and military activities took up a large part of the time and thoughts of the men and youths. Raids and tribal wars are no longer a threat to the Saudi Arabian Bedouins, but instead of returning to full-time herding activities, they seek outside work as wage laborers. Many also continue military activities but in the service of the kingdom of Saudi Arabia rather than against each other. Their relationship with the modern kingdom of Saudi Arabia is a long one, for it was their fighting in the armies of the fanatical Ikhwan (Brothers) during the early decades of this century that provided King Abd al-Aziz Ibn Saud, the father of King Faisal, the main support he needed for unifying the disparate regions that now make up modern Saudi Arabia.

With the increased ease of travel in the desert by means of trucks, many Bedouin males are now able to combine herding activities with military service and part-time employment. There is, in fact, a great deal of coming and going of men between the desert camp and the city, but the herds and the women are prospering in the desert; thus, to the Bedouins, they are still in control of their major resource, the pasture lands of the desert. Even if the romantic days of camels and raids are over, the Bedouins acknowledge that life has not changed much; they are still pastoralists, and their society and culture remain relatively intact. While the Bedouins undoubtedly have a higher living standard and enjoy a much greater degree of security than they did before the development of the oil industry, the gap between their standard of living and that of many of the townspeople persists and is even widening. ☐



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Cabinets of Curiosities

Continued from page 42

dustry is the description of early technological devices, such as diving bells, hydraulic contrivances, various applications of the magnetic principle, and some proposed methods of flight. Among these was Francesco Lana's airship designed to rise after all air had been pumped out of copper chambers placed fore and aft on the body of the vessel. Its navigator directed the course with the aid of a telescope and two globes: one terrestrial, the other astronomical.

But the main value of Valentini's effort rests in the illustrations he gave of unusual items and the period glimpse he provides of such an establishment as the Royal Library and Rarities Chamber in Vienna. Shelves and displays there climbed to dizzying heights on the walls; scholars were apparently expected to combine exhaustive research with exhausting acrobatics.

Valentini's catalog notwithstanding, hodgepodgery was slowly giving way to systematization, a necessary element in the design and function of any museum. At Naples, Ferrante Imperato, an apothecary, had a botanical garden and a choice collection confined to articles of nature. Comparative studies at last crossed the threshold of possibility as Imperato amassed written observations and corresponded with many of Europe's leading naturalists. He also published a Natural History in twenty-eight books (chapters) in 1599. Not very scientifically contrived, it describes a random selection of plants, stones, and some living creatures. But it was the occasion for an ingredient of the scientific scene that has remained fairly constant ever since—heated controversy. Many said that Nicolas Stelliola wrote the book and sold it to Imperato for 100 ducats. The argument will never be resolved, but it can be said in Imperato's favor that much of the Natural History's content is similar in substance to his scientific correspondence.

At about the same time, Ole Worm, a universal scholar who was a physician, teacher, antiquarian, and a pioneer in paleontology and archeology, set about gathering materials for his own museum in Copenhagen. While it included items

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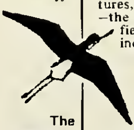

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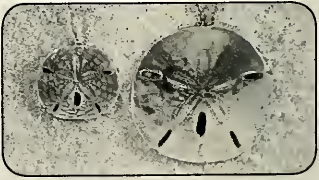

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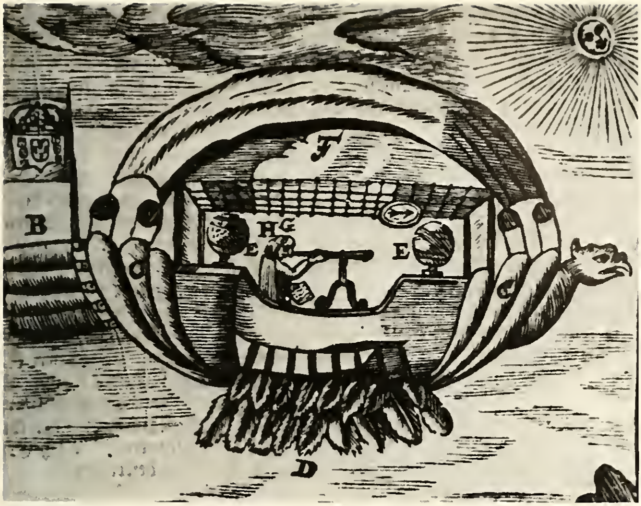

Francesco Lana's design for an airship as depicted in Valentini's eighteenth-century catalog of museums.

FRANK J. ANDERSON

from the tropics and foreign places, it focused chiefly on the natural, anthropological, and archeological history of Denmark and Scandinavia. Polar bears, kayaks, tortoises, and armadillos shared display areas with narwhal tusks, Laplanders' costumes, Chinese astrological instruments, Maya manuscripts, and runic inscriptions. Despite the genuine scientific ability of its author, some of the character of the age persists in the pages of his catalog. Published in 1655, just one year after Worm's death, the catalog still treats, at length, the puzzling matter of the barnacle goose, solemnly setting down in order all of the variant explanations of the mythical generation of a very real bird.

Varied displays were also fashionable in the London coffeehouses. Izaak Walton speaks of one in Westminster where, to lure patronage, the proprietors exhibited prize catches. One of the last such establishments was Don Saltero's in the Chelsea area of London. Despite his Spanish-sounding name, which he adopted for its exotic flavor, Saltero was an Irishman and one-time ser-

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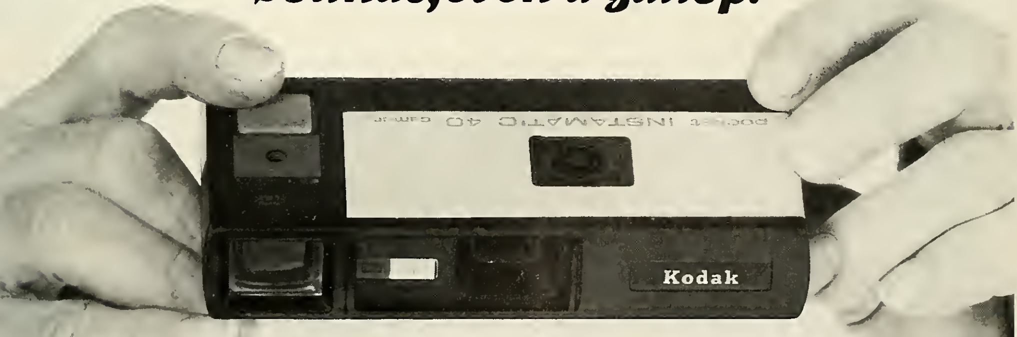

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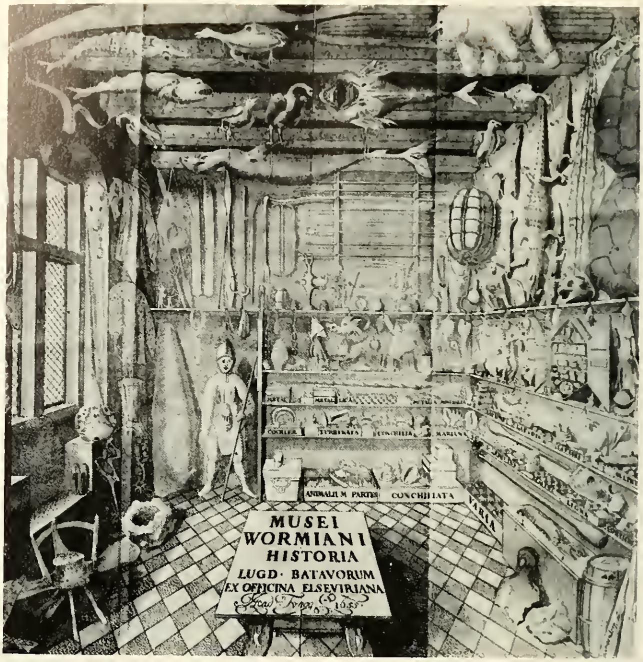
Reflecting the "pack rat" style of early collections. Ole Worm's Danish museum displayed polar bears alongside Maya manuscripts.



FRANK J. ANDERSON

vant to Sir Hans Sloane, the famed British naturalist. Through the good offices of Sloane, whose patronage and presence at the Cheyne Walk coffeehouse helped to popularize it, Saltero's gained much celebrity. Richard Steele described it in the *Spectator*, and such personages as Benjamin Franklin, the Earl of Sutherland, and Sir Robert Cotton visited it. It was among the last survivors of the *omnium gatherum* style in museums, mixing Madagascar lances and necklaces of Job's-tears with models of the Holy Sepulcher and Henry VIII's coat of mail.

Richard Bradley, Member of the

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ZR-8
VIRGO
Aug. 24-Sept. 23

ZR-10
SCORPIO
[illegible]-Nov. 22

ZR-9
LIBRA
Sept. 24-Oct. 23

Royal Society of London, who visited Saltero's in its heyday, used some of its specimens to illustrate his *Philosophical Account of the Works of Nature*, published in 1721. In particular, he depicted the sirenfish, forever ending the legends that were still swarming about it in his time. The society to which he belonged was doing excellent work along the same lines—that is, seeking out rational, scientific explanations for natural phenomena.

First formed as an irregular gathering of individuals who called themselves the Invisible College, the Royal Society was chartered in 1663. It soon forged into a leading position in scientific achievement. Both the British Museum and the allied Natural History museum were created out of its labors and its multitudinous collections. While such notables as Robert Boyle, Nehemiah Grew, and Hans Sloane get, and deserve, much of the credit for the Royal Society's accomplishments, one of its quieter workers, Daniel Colwall, is rarely mentioned. Yet Colwall had used his own funds to obtain the collection with which the Society began forming its holdings.

The latter half of the seventeenth century saw a rapid increase in the number and quality of scientific collections, as well as the development of new interests by royal or aristocratic collectors. Colorful curiosities dropped out of favor, and emphasis was placed on gathering those things that furthered the search for accurate knowledge about natural phenomena. Men no longer sought out the magical properties of the unicorn's horn, but instead began observing the secrets of nature through the microscope.

The French Academy of Science, which had met irregularly for some thirty years, held its first chartered session in the Royal Library at Versailles on December 22, 1666. Descartes, Pascal, and Huyghens were members of the earlier, unchartered group; later it attracted such scientists as Laplace, Buffon, Lavoisier, and Sir Isaac Newton. Despite its fame and magnificent work, it perished in 1792 during the Revolution; many of its members went to the guillotine while others were impoverished.

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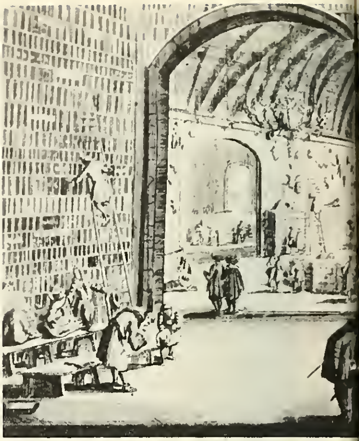
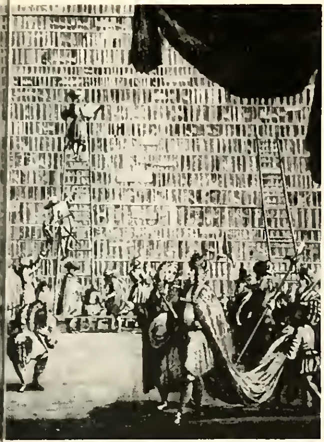


FRANK J. ANDERSON

apothecary in Amsterdam who was a Colleague of the Leopoldine Academy, Member of the Royal Society and the French Academy of Science, and Fellow of the Institute of Bologna. He prospered in his endeavors, bringing together a vast collection of natural history specimens. In 1716 he sold it to Peter the Great for 15,000 gulden ($83,000) and promptly set about making an even larger cabinet of curiosities, which he obtained from the same source as the first—the docks of Amsterdam.

When Seba began cataloging his museum in 1734, he attempted to enlist the services of the young Linnaeus. Since Linnaeus was too busy, he recommended his friend, Peter Artedi, and so set in train an unfortunate sequence of events. Artedi, who had inspired much of the Linnaean system, soon became a friend of Seba's and was invited to dine at his home. Returning in the dark from the festive occasion, Artedi lost his way and drowned in one of Amsterdam's many canals. His death delayed further cataloging, and the work, incomplete at Seba's own death a year later, was finally finished thirty years later.

Of the early museums only one, the Ashmolean of Oxford, has survived to the present day in its original form. Properly, it should be called the Tradescantian, since John Tradescant and his son first brought it together. Under them it became one of the great sights of seventeenth-century London, and its fame spread over the Continent as well. Like Prince Rudolph's



In the Royal Library and Rarities Room at Vienna, "scholars were . . . expected to combine exhaustive research with exhausting acrobatics."

hoard, it too possessed a complete dodo, but only the skull and foot are extant.

As for the attachment of the Ashmole name to the Tradescants' museum: the antiquarian Elias Ashmole felt that he would assure his immortality by acquiring the museum and donating it to Oxford. Addicted to astrology and not overly learned, he was, as John Evelyn put it, "most industrious," and knew well how to gain his own ends. He succeeded in obtaining the Tradescants' museum, but his fame has been a bit tarnished by his methods, which included intimidation and legal harassment.

Not all the Tradescant material survives at Oxford; it is unlikely that such items as the claw of the roc or scenes cut in paper by various emperors remain on view. But the material that accompanied such trivia roused interest in, and paved the way for, today's accessible and scientifically useful collections of natural history. Without the Ashmolean and its predecessors, we would have fumbled longer through a chaos of fantasy where basilisks were bred of cocks' eggs and lead could be made into gold. ☐

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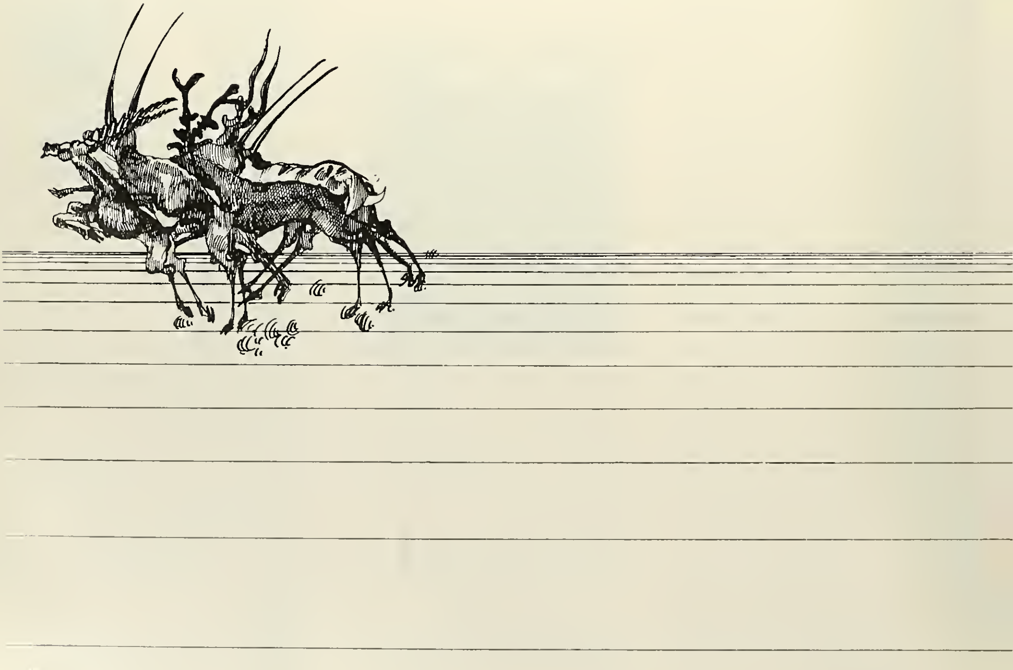
Back to the Bow and Arrow

The Tender Carnivore and the Sacred Game, by Paul Shepard. *Charles Scribner's Sons, $9.95; 303 pp., illus.*

As one starts to read this thought-provoking book, one senses the presence of the utopian reformer. "Stop the world," it seems to say, and rather than the "I want to get off" of the disillusioned, it hints that we should all start over again, because we—or rather, the author, Paul Shepard—can rectify the error of our ways. Never mind that the likes of Buddha, Christ, Mohammed, Karl Marx, B.F. Skinner, and Maharaj Ji have been equally confident that they have discovered "the way," or that nothing suggested so far has proved to be workable. Shepard's solution is obliquely suggested at the end of the first chapter. After claiming that "the urban crisis is a direct consequence of the food-producing revolution," he asks rhetorically, "Can we face the possibility that hunters were more fully human than their descendants? Can we embrace the hunter as part of ourselves, as a step toward repairing the injury to our planet and improving the quality of life?" The uneasy suspicion that the reader may feel concerning Shepard's implied answer tends to fade into the background during the next four and one-half chapters, only to return with a rush in the ludicrous last twenty pages. To express it in the mildest of terms, what a pity!

Biological determinism has been a wondrously salable commodity in the last several years. We have seen Konrad Lorenz (*On Aggression*) capitalize on the idea of the innate aggressiveness of mankind; we have seen Robert Ardrey (*African Genesis,* etc.) make a substantial living from the idea that original sin (= predestination = the innate depravity of mankind) is proven by the evidence (nonexistent) that *Homo sapiens* is descended from a



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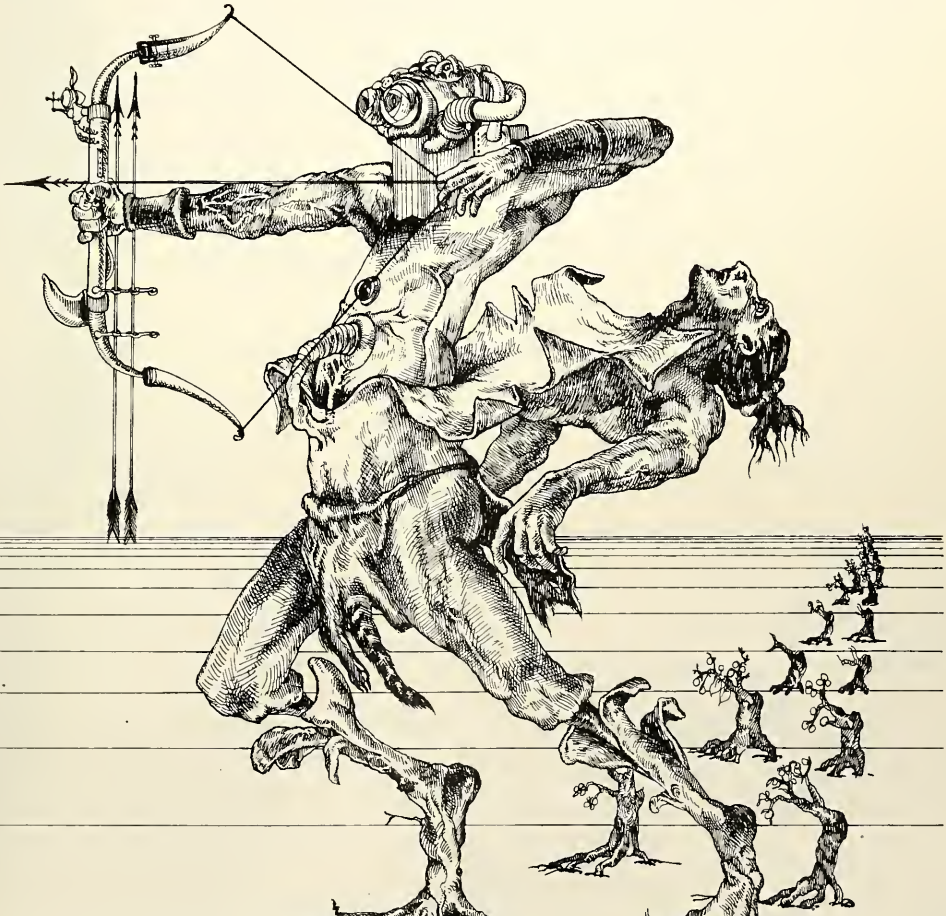

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"killer ape"; and we have seen Desmond Morris make a small fortune by appealing to the prurient interests of the reading public, suggesting that the pectoral fat pads of feminine humanity represent a transposition of the iridescent anal display of a baboon in heat. Supposedly, the snow-white hemispheres "tipt with vermillion" in the human female serve to stimulate in the same manner as the incandescent perineum in the distaff monkey. That Morris is blatantly ethnocentric in an Anglo-Saxon way is bad enough, but the display of biological ignorance—the average human female is chocolate in color and is only slightly darker in pigmentation for mammary areolae and everted oral mucosa—is simply inexcusable. Never mind. It has proved to be immensely readable and it has provided him with an income that can be exceeded only by those who dispense synthetic emotions for public display (actors) or who rearrange each other's features in sudden and unpredictable ways (professional pugilists). But, alas, one fears that Paul Shepard will achieve neither the readership nor the financial rewards of the worthies just mentioned. And more's the pity, because, with the exception of his disastrous concluding section, most of what he has to say is far more deserving of serious attention.

So what does he say and what are his conclusions? I shall consider the latter first because the sooner we get them out of the way, the sooner we can consider the genuine contribution of this remarkable book. Ardrey and Shepard both agree that mankind has been unalterably stamped by his carnivorous heritage, but they differ in fundamental, if traditional, ways on the consequences. Ardrey, in the tradition of the grim Calvinist, allegorically equates hunting with "the Fall," and concludes that human life must consist of a consequent and unavoidable purgatory amounting to eternal damnation. While the language purports to be that of science and reason, the message amounts to "accept, for it is written!"

Shepard, on the other hand, believes that although the hunting period in man's past has indeed shaped his nature, this is not an unrelieved evil. In the tradition of religious mysticism, which has demon-

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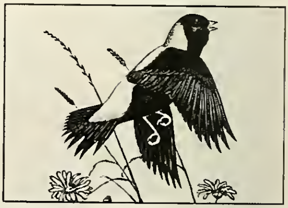

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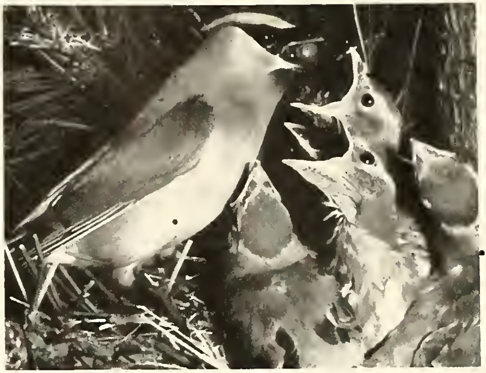
strated such a continuing appeal—and has produced so many heresies—Shepard feels that salvation can be attained by raising the consciousness of basic human nature to the level of the ecstatic. But his apotheosis is not the one achieved through the euphoria of drugs, the solitude of the retreat, or the mass hysteria of the revival tent or the rock concert. Rather, it is at the moment of the hunter's triumph over his prey, the instant of the kill. If human evolution shaped man as a predator, then the epitome of humanity is reached in the culmination of the chase.

Hunting, Shepard recognizes, is not a dietary necessity. Instead, it represents a kind of sacrament. The pursuit of prey then becomes a form of religious activity, the "sacred game" of the title. With a mystical mixing of metaphors, the animals pursued take on aspects of sanctity that render them also "sacred game." And man "because he is a hunter . . . is the most deeply loving and profoundly compassionate animal," a "tender carnivore" who regards his victims with true love. As Shepard rapturizes, "the ecstatic consummation of this love is the killing itself." Although this same "logic" could be applied to a Spanish bullfight where, as Tom Lehrer has observed in his celebrated ballad, the drama reaches its peak when a lone man steps forth to face "half a ton of angry pot roast," oddly enough Shepard makes no attempt to compare his own brand of *machismo* with the vicarious version so admired in Latin lands. He does quote extensively and with approval from Ortega y Gasset's *Meditations on Hunting*, but goes one step beyond the Spanish philosopher by insisting that, after the "ecstatic consummation," the meat thus acquired should be ritually ingested—"Formal consummation is eating," or one might say, consumption should succeed consummation.

The height of Shepard's mysticism is reached when he ties together the manifestations of killing and sexuality. "Both have to do with the most profound of life's passions, the demonic moment of the kill and of orgasm. These two powerful expressions are related. Both lead to life and to death, which, like maleness and femaleness, represent



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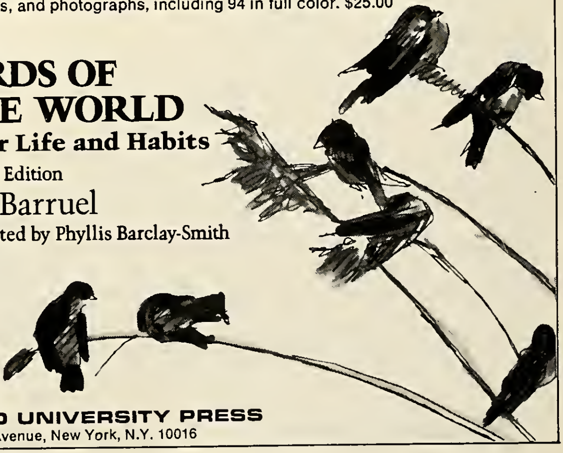

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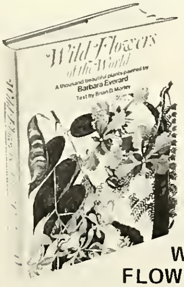
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a fundamental polarity." Perhaps, and perhaps not. I have chosen to quote this passage rather than to try to paraphrase it because the type of insight represented belongs more in the realm of the poet than the scientist, and a rewording can only diminish the author's intent.

Possibly the very idea of utopia is essentially poetic, which may be why all efforts to draw up workable plans seem so absurd. Paul Shepard's scheme is no exception. A "five-mile-wide ribbon of human settlement" around the edges of the continents and islands of the world, cities averaging 50,000 inhabitants architecturally separated into groups of 500 within which family combinations live in formal social units of no more than thirty, organized around the preparation and eating of food—the latter derived principally from microbes grown on petroleum. The central three-quarters of each land mass would be returned completely to its wild condition, and entered only by men on foot, possessing simple, hand-held weapons—no guns, cameras, or vehicles, no dogs or other domestic animals. The educational regimen required to run such a world is specified in some detail and exceeds even those postulated by Aldous Huxley and George Orwell. Children should be allowed to read but only to a circumscribed and limited extent. Chemistry, mathematics, and physics are taboo until nearly the age of twenty, and the study of documentary history should be delayed still longer. Art history and museums are anathema. So are pets and pictures or any other representations of animals. Boys and men would be required to sally forth periodically on compulsory killing expeditions; girls and women would mount parallel forays for gathering purposes.

Shepard serenely believes that his model can work by the year 2020, but even if one could cram everyone into seaside cities, restore nature in the raw, and mold the mass mind to the model proposed, the vision of eight billion people streaming forth into the interior, sticking anything that moves, and collecting everything that doesn't, would destroy his utopia in short order.

But this picture is the result of just the last twenty pages. As I said

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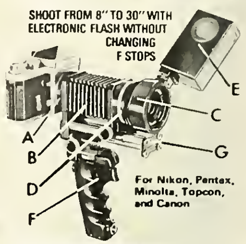

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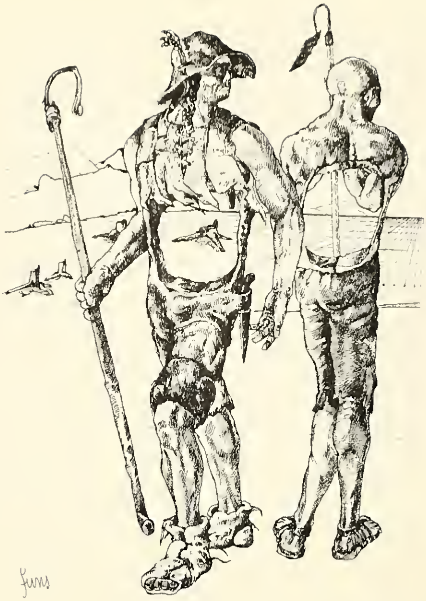
earlier in this review, what a pity! Why spoil so much excellent writing and critical insight with what amounts to an intellectual pratfall right at the end? After all, anyone who characterizes Iowa as "among the most mismanaged lands in the world" can hardly be all bad. Perhaps Shepard, realizing that the majority of his book was a critical indictment of many of the underlying beliefs of our way of life, felt impelled to go on record as more than just another negative voice. Would that he had resisted the urge.

The scope of the book, prior to its final collapse, is vast to the point of being breathtaking, and the author is evidently well prepared to handle that interface between human biology and human behavior that is represented by the field of biological anthropology. Lately Paul Shepard has been Visiting Professor of Environmental Perception at Dartmouth College—a curious sort of title, but then Dartmouth College, swinging with the current



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of the times, has decreed that the principal criterion to fill its recently created position in biological anthropology is that the applicant must be female—ability and experience being of distinctly secondary importance.

Shepard is no less a biological determinist than those who would have us believe that the hunting way of life in man's past is responsible for such human ills as war, pollution, and urban blight. However, in contrast to such well-publicized views, Shepard blames the increasingly noxious human predicament on the abandonment of predation. The "Fall" was not in the adoption of carnivorous ways but in their abandonment in favor of farming. He exposes the revisionist attitudes in which "the weaknesses of agriculture have been projected upon hunters." "The farmer as a model of virtue and as a being close to nature is as false an image as that the cultivated and grazed landscape is nature. To the land-user are transferred qualities of social and ecological maturity and sensitivity in fact found only among hunters. This ancient fraud has misled thousands of hopeful and conscientious people into aspiring to go back to the farm in the vain hope of retrieving what the city took. In potato grubbing they will painfully act out their fantasies; in disillusion and puzzlement they will return to the city," for as he observes elsewhere, "the mystery of life does not reveal its secrets to bean-eaters as opposed to bison-eaters."

One may quarrel with some of his claims and with his curative prescription, but he sustains more than two-hundred pages of insight following dazzling insight presented in a smooth, almost lyrical flow of writing. Although his presentation is not footnoted, there is a large appended bibliography, and from the context it is clear that Shepard has read and absorbed it all. Adding further to the impact are the arresting surreal drawings by Fons van Woerkom.

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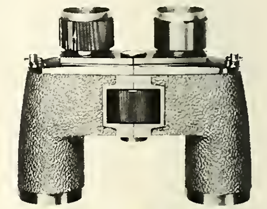

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rized; the archeological record is scrutinized and the evidence for the increasingly detrimental ecological impact that the food-producing revolution created is all presented in lucid and readable form. But the greatest impact that the book could have is in its powerful and convincing indictment of the farming way of life, both for the ecological damage it has created by past and present practices and for the brutalizing effect it has had on the human psyche. Everything from the "coarse sullenness" of the peasant outlook, to the degradation of the female role, to "the debauchery of alcohol and drugs," to the "depersonalizing and socially destructive" phenomenon of urban life, to war—"in fact, the swords of war are hammered from plowshares"—all the ills of mankind are tied to the effects of a farming way of life. Last, but not least, the promise embodied in the Green Revolution is subjected to a well-informed examination. Shepard concludes that it is a prescription "for ecological disaster" and that "the consequences will make past famines in India look like minor incidents."

As an apologia for the human hunter, the book surely must be the best in print, although, since Shepard insists that hand weapons only be used, this would hardly apply to the army of middle-aged "masculinity" that waddles off to the woods each fall to blaze away at anything animate, including each other. If only Paul Shepard had resisted the temptation to present his recipe for utopia in the last twenty pages or so, he would have written a brilliant book destined to make a lot of people do some hard thinking about many of our traditionally unquestioned values. But those last pages are simply a naïve and painful embarrassment, and the edifice that had been built with such brilliance over the previous two hundred or so pages collapses in a shambles. Brilliance there is in abundance, but as a book, it is a brilliant failure.

C. Loring Brace is professor of anthropology at the University of Michigan and curator of physical anthropology at the university's Museum of Anthropology. He is presently visiting professor of anthropology at the University of Auckland in New Zealand.

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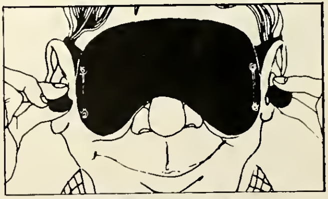

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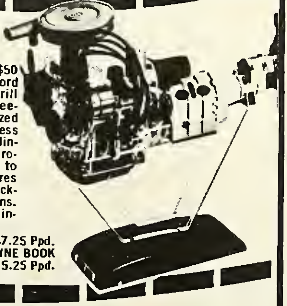

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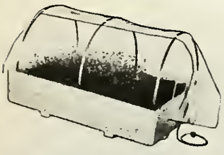

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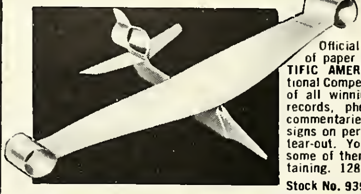

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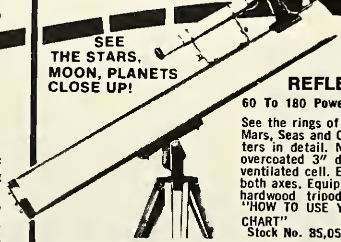

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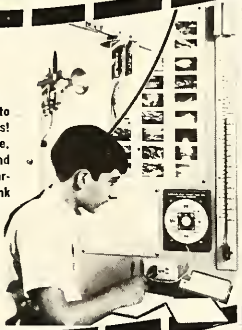

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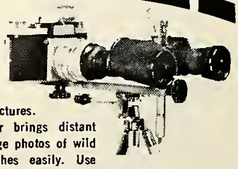

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More Reviews

One Cosmic Instant: Man's Fleeting Supremacy, by John A. Livingston. *Houghton Mifflin Co., $5.95; 243 pp.*

On television a short time ago I heard a spokesman for the development of the New Jersey meadowlands say, "Progress calls for the development of land so near Manhattan." The absurdity of that statement, its utter madness, is typical not only of developers but of the kind of thinking of all who identify progress with man's blundering, greed-inspired attempts to improve upon nature. It is a psychosis that is destroying America and many other parts of the world, animate and inanimate. It is this psychosis and its origins that John Livingston, professor of environmental studies at York University, Ontario, examines in this moving book. Moving because the story it has to tell is a sad one. Livingston tells it from the viewpoint of a naturalist, but had he been an anthropologist, with the insights that living among "primitive" peoples affords one, the story would have been sadder still. Nonliterate peoples generally maintained a beautifully balanced relationship between themselves and the natural world. That balance was upset when men became urbanized, but the psychosis, developed by man during the industrial revolution, did not really get under way until the middle of the eighteenth century. Since then its despotism, disguised as progressive technology, has "progressively" laid waste not only to the environment but also to man. For man is a part of the great harmony of nature, so that any disharmony introduced into that great orchestration is likely to affect in some way every other part of it. The refusal to understand this is one of the evasions of the contemporary conscience. Some of us are

WORKING WITH NATURE
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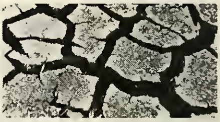

MAN IN TROPICAL AFRICA
The Environmental Predicament

By **D. F. Owen.** Can attacks on disease, insects, and malnutrition actually diminish the quality of life by upsetting the ecological balance? D. F. Owen finds disturbing signs in a region of rapid environmental change. $7.95

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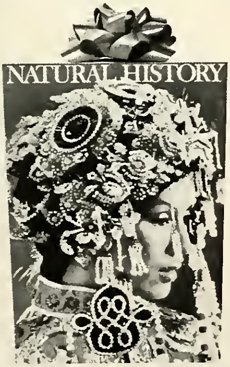

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TODAY WE'RE ALIVE THANKS TO YOU!

But frankly, we still need your help. So without any further ado, we would now ask you to continue in the battle to keep alive and free, the heritage of East African wildlife that belongs to everyone-especially you. What a pity it would be should your child's next question be "What WAS . . ." rather than "What IS a Cheetah?" But that could be the case with cats and other species if the numerous activities of the East African Wild Life Society have to be curtailed for lack of funds. Cheetah, lion, leopard and other animals of the region if not protected, may take their place in the history books, alongside the Dodo, just as dead, just as extinct.

The East African Wild Life Society founded in 1961 is a non-profit, non governmental agency assisting the three East African republics of Kenya, Uganda and Tanzania in the development of game conservation. The facts and figures of its performance may be seen in its numerous activities, such as pollution study, anti poaching work, research, education and animal rescue. During the 1970 to '72 period, accomplished and projected plans amount to $185.000.00. Membership and interest in the Society is up, there's none other like it in the animal kingdom! But costs and commitment are recurrent-and there's always room for one more in the ark. Your readership proves your interest.

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concerned, but too few of the concerned are involved. If we continue this way there can be no doubt of the fate of the species that is too clever for its own good. It is not enough to be clever, it is also necessary to be good, and goodness means being deeply involved in the welfare of the other—to confer survival benefits in a creatively enlarging manner upon the other in an ongoing reticulum of interconnectednesses with the whole of nature.

This goodness is something that men once had, and the manner in which they came to lose it is effectively told in this book. From the Aristotelian view that there was no purpose for anything in the world except for human deeds and human artifacts, to the developed Christianity of the Calvinists and their Puritan successors, with its terrible injunction to "Be fruitful, and multiply, and replenish the earth, and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth," Western exploitative industrial man has convinced himself of his supremacy over the whole of nature and has religiously lived by the biblical injunction, until it has brought him to the sorry pass in which he now finds himself. "Something in the biosphere," writes Livingston, "is drastically out of synchronization with everything else. That *something* is man." Western industrial man. We must have the courage and the will, he emphasizes, to challenge our fundamental assumptions concerning our relationship to the rest of nature, the nature of which we are a part.

Humanity evolved as an intelligent species largely because human beings were able to make the most appropriately successful responses to the challenges of the environment. From the standpoint of the anthropologist looking back over the history of man's evolution during the last five or more million years, it is only very recently that he began to make inappropriate responses. But, as Livingston points out, there is time, even though it is short, in which we may learn to behave intelligently once more. Toward that end Livingston's book constitutes a splendid contribution.

Ashley Montagu

The Sand Country of Aldo Leopold

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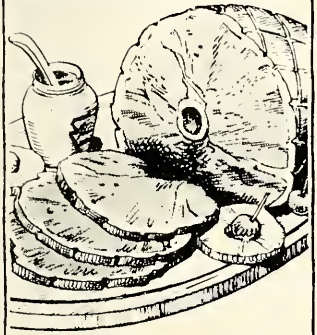

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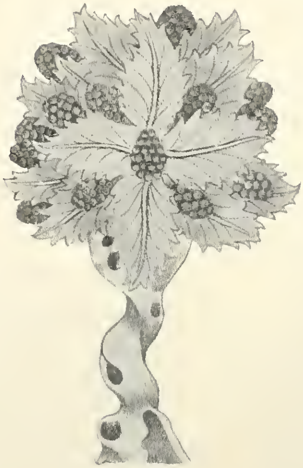
FLOWERS AND TREES OF TUDOR ENGLAND, by Clare Putnam. *New York Graphic Society, $13.50; unpaged; illus.*

The New York Graphic Society has made available at a modest price this fine reproduction of early sixteenth-century illustrative art. Here are thirty-two full-color plates from the volume in the Bodleian Library at Oxford known as MS Ashmole 1504. The main subjects are plants, trees, and shrubs embellished with a miscellany of Tudor landscapes, household utensils, musical instruments, insects, and animals. These primitive, highly stylized pictures, totally lacking perspective, make no attempt at botanical accuracy; yet their identity is unmistakable. Opposite each plate is an entertaining commentary by Dr. Clare Putnam on the origin, history, herbal properties, and legends of the plants depicted. The manuscript was thought to be the "pattern book" of a manuscript illuminator but it might also have been designed as a picture book for a child. The artist is unknown.



In the Introduction, Dr. W. O. Hassall of the Bodleian Library gives a scholarly account of the history and probable origins of this Ashmole manuscript and discusses the school of illumination to which it belongs. He writes:

"Elias Ashmole (1617–92) was a

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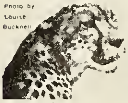

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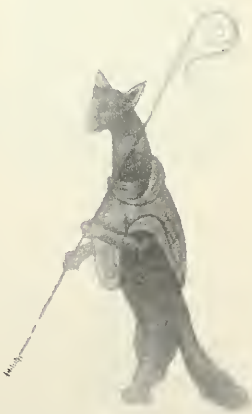
man of wide interests. These included heraldry, local history, alchemy, astrology and poetry. . . . He acquired for his library various collections of papers including those of Simon Forman (d.1611) and William Lilly, the astrologer. The 'curiosities' which he inherited from John Tradescant formed the nucleus of the museum which he founded and which commemorates his name. He placed them in a building completed in 1683, later called the Old Ashmolean wherein the museum of the history of science is now housed. . . . His manuscripts, together with those of Anthony Wood and William Dugdale, were transferred from the Ashmolean Museum to the Bodleian Library in 1860."



According to two authorities, Prof. Otto Pacht and Dr. Jonathan Alexander, the date of the Ashmole manuscript is between 1520 and 1530. It therefore offers curious examples of some of the popular herbs in use in the early sixteenth century. The incidental illustrations, arranged at the base of each plate, afford glimpses of birds, beasts (both mythical and real), coats of arms, and numerous subjects and objects of the English Tudor period.

This attractive, well-made book should appeal to bibliophiles, herb enthusiasts, artists, and all who have an appreciation of plants and their portrayal in the graphic arts.

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Celestial Events

by Thomas D. Nicholson

Sun and Moon The sun moves continually southward with respect to the earth's Equator, resulting in shorter days and longer nights in the Northern Hemisphere. The moon is at last-quarter phase on November 17, new moon on November 24. The early evening crescent should be visible by November 27, and the moon remains in the evening sky past first-quarter on December 2 to full moon on December 9.

Planets Three planets are in the sunset sky and two in the dawn sky. At dusk, look for Venus low in the southwest, setting shortly after dark; Jupiter high in the southwest in early evening, setting before midnight; and Mars high in the east, setting after midnight. Saturn rises in the east before midnight. Shortly before sunrise, Saturn will be in the southwest; Mercury, about a week before and after its greatest westerly elongation on November 27, will be in favorable position low in the east.

Partial Lunar Eclipse Observers throughout North America will be able to see the partial eclipse of the moon that occurs on December 9, although only a small arc of the moon's lower edge will enter the earth's shadow. A darkening along the bottom edge of the moon will begin to appear at about 8:09 P.M., EST, proceed to the right across the bottom edge, reach maximum size (covering about 10 percent of the moon's diameter) at about 8:45 P.M., and leave the moon at about 9:20 P.M.

Comet Kehoutek If this newly discovered comet does brighten as anticipated, it should be visible in the morning sky from about mid-November to mid-December. Look to the southeast, near the horizon, about two hours or so before sunrise. Although the comet should continue to brighten after mid-December, it will be moving closer to the sun and will be spending most of its time in our daylight sky. It should be brightest and easiest to see about mid-January when it will be in the evening sky.

November 17: The Leonid meteor shower reaches maximum. Although the last-quarter moon will brighten after-midnight skies, this well-known shower often produces very swift and bright objects. Counts in normal years are about 15 per hour.

November 19: Mercury becomes stationary and resumes direct (eastward) motion.

November 27: Mercury is at greatest elongation to the right of the sun, making it a favorably located morning star, rising about two hours before the sun. Mars is stationary and begins to move eastward (to the left) back toward Aries.

November 28: Moon reaches apogee, farthest from earth. Venus is below and to the right of the crescent moon.

November 29-30: Jupiter is near the moon on both nights.

December 5-6: Mars is near the moon on both evenings.

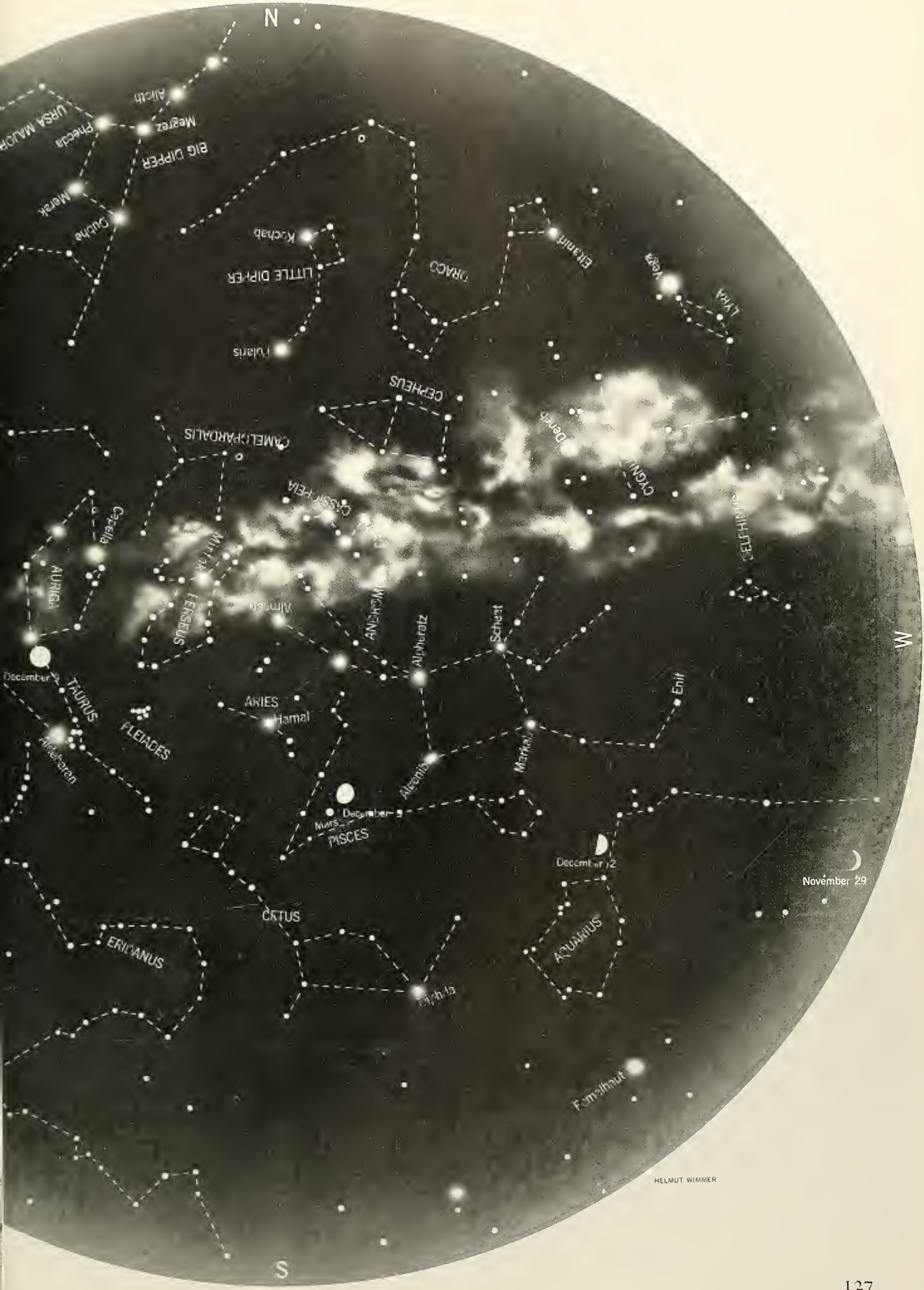
December 9: Partial lunar eclipse, visible in North America.

December 10: Moon is at perigee, and perigee spring tides (higher highs) follow the full moon of the 9th. Saturn is quite close to the moon in the early evening. Just after moonrise, observers in northeastern United States and eastern Canada will see the moon pass in front of Saturn. The occultation will last about an hour.

December 13: The gibbous moon, bright in the morning sky, will interfere with observations of the Geminid meteor shower. One of the more productive annual showers (50 meteors per hour per observer) the Geminids reach maximum tonight.

★ Hold the Star Map so the compass direction you face is at the bottom, then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:15 P.M. on November 15; 9:20 P.M. on November 30; and 8:20 P.M. on December 15; but it can be used for about an hour before and after these times.

December 12
Pollux
Castor
E
Procyon
Betelgeuse
Saiph
Sirius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NATURAL HISTORY

Incorporating Nature Magazine
Vol. LXXXII, No. 10
December 1973

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Gardner D. Stout, President
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Authors

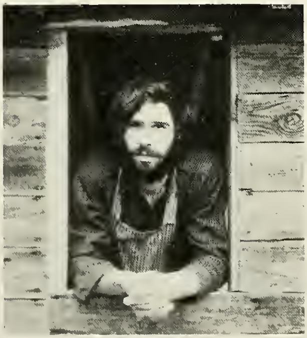
Asked why he studied food-related energy consumption, **Eric Hirst** replied, "I've always been thrifty; my wife would say cheap." Hirst, a research engineer in the Environmental Program at the Oak Ridge National Laboratory in Tennessee, is studying energy-use patterns in hopes of slowing growth rates and minimizing environmental degradation. He is now analyzing total energy requirements for bicycling, part of a study on urban travel. Hirst is the author of "In Praise of Hikers, Bikers, and Crowded Cars," *Natural History*, August-September, 1972.

Eric Hirst

A native of Long Island, **Robert Wassman** acquired an interest in the flora and fauna of the sea at an early age. Now a first-year student at Albany Medical College in New York State, he was a biology major at Yale University, where he did research for two years under the supervision of Prof. **Joseph Ramus.** Ramus grew up in Detroit, about five hundred miles from where *Codium fragile* made its initial appearance in the northeast. He first learned of the alga in 1964 when he was a summer student at the Marine Biological Laboratory at Woods Hole, Massachusetts, and has been studying this colonizing seaweed ever since.

Robert Wassman and Joseph Ramus

After several months of research on first-century Jewish history, **Christopher L. Hallowell** went to Jerusalem last summer to observe recent archeological excavations. He conferred with historians and field archeologists and explored the excavations near the site of Herod's Temple. Hallowell, an associate editor at *Natural History*, was most interested in relating early historical accounts to the new archeological findings. He is currently preparing another article on an incident in North American marine archeology.


Christopher L. Hallowell

Donald Richie has been interested in Japanese tattooing since he first went to Japan in 1946. In collaboration with Ichiro Morita, he wrote the standard bilingual book on the subject, *Irezumi—Japanese Tattooing*, published in 1965. Now a resident of Tokyo, Richie is director of Zokeisha Publications. He was formerly a curator in the Department of Film at the Museum of Modern Art in New York and, from 1953 to 1968, film critic for *The Japan Times*. Photographers **George** and **Claire Louden** became interested in the subject of Japanese tattooing during an eight-year residence in Japan. They are a husband-wife team of free-lancers, whose drawings and photographs, stemming from 25 years of world travel, have appeared in numerous books and magazines.

Intrigued by the role of birds in Indian mythology, **Paul A. Johnsgard** two years ago began to study and write about snow geese. His interest led to field work on the west coast of Hudson Bay and to a book, *Song of the North Wind—A Story of the Snow Goose*, to be published by Doubleday in the spring. Professor of zoology at the University of Nebraska at Lincoln, Johnsgard studies the behavior and ecology of waterfowl and gallinaceous birds and is now at work on a monograph on the waterfowl of North America. He is also the author of "The Evolution of Duck Courtship," *Natural History*, February, 1968.

Paul A. Johnsgard

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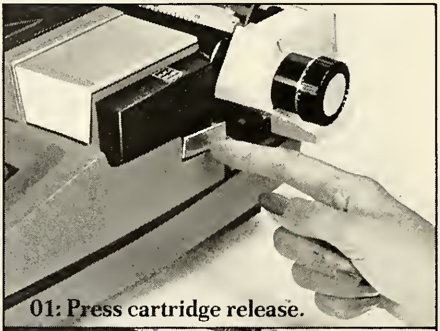

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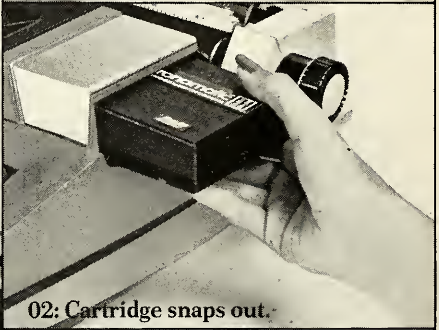
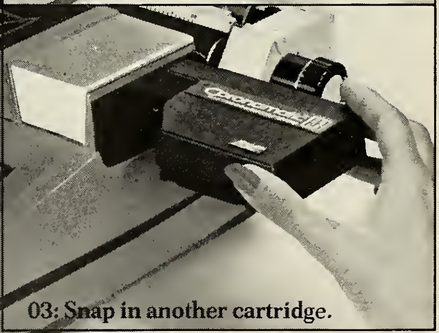


02: Cartridge snaps out.



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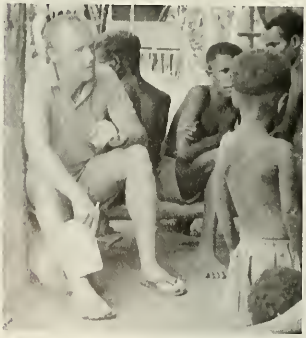
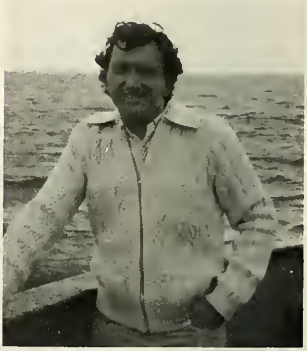
Wang Sung and Lu Chang-kun, authors of "Giant Pandas in the Wild," are research assistants at the Institute of Zoology, Chinese Academy of Sciences. The article is adapted from "The Giant Panda," which appeared in *China Reconstructs*, May, 1973.

Vincent Sarich

When **Vincent Sarich**, a biochemical researcher, obtained blood and tissue samples from Chi-Chi, the giant panda that died in London in 1972, he was all set to plunge into the controversy over the animal's origins. The project, initiated by Ron Reuther, then director of the San Francisco Zoo, was carried out in Sarich's laboratory at the University of California at Berkeley, where he is associate professor of anthropology. Best known for his work on the molecular aspects of human evolution, Sarich is especially interested in the "molecular clock" concept—dating evolutionary divergences using molecules.


William E. Mitchell

William E. Mitchell, his wife, and their two children, aged four and five, lived for two years among the Wape and Lujere tribes of Papua New Guinea on what Mitchell refers to as a "family expedition." During this period he did medical anthropological research on how cultural systems define and correct deviant behavior. Mitchell, an associate professor of anthropology at the University of Vermont, became interested in the study of therapeutic cultural systems in 1967 while a member of an American Museum of Natural History anthropological expedition to New Guinea.


Patrick A. Mulloy

A former foreign service officer, **Patrick A. Mulloy** is presently a trial attorney in the Pollution Control Section of the U.S. Department of Justice and chairman of the Environment Committee in the International Law Section of the American Bar Association. While in the State Department, he worked on law of the sea policy and attended meetings of the U.N. Seabed Committee. His current concern is with the development of international environmental law and institutions. "We know certain environmental problems such as marine and atmospheric pollution must be handled internationally," he writes, "but creating the institutions by which sovereign national states will do so is a problem that needs exploring."

Gregory Benford, this month's "Sky Reporter," is a professor in the Department of Physics at the University of California at Irvine. His article is adapted from *Astronomy and Life in the Universe*, by Barry Parker and Gregory Benford, to be published in 1975. □

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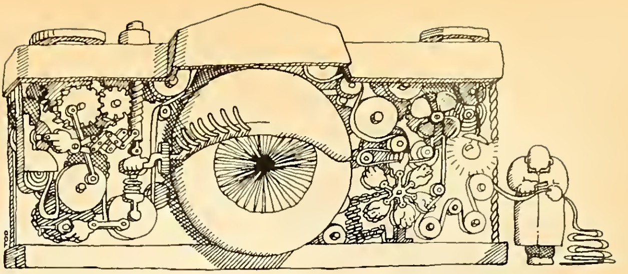
Letters

Human Evolution

The two letters in the October, 1973, issue commenting on "The Other Genesis," by Salvador E. Luria [June-July, 1973], caused me to reread that article and triggered this letter. Surely, when the author wrote "a nucleic acid molecule learned to direct the assembly of a protein, which in turn helped the copying of the nucleic acid itself," most readers know he did not mean "learned" as would be done in some sort of school. Rather, he meant "learned" through the method of trial and error. When one considers the tremendous number of atoms and molecules continuously interacting, the billions of years this has been going on, the number of reactions going on simultaneously and, therefore, the superlarge number of reactions that have occurred, it is not astonishing at all that man evolved into existence.

I find Mr. Luria's article most plausible and much more believable than the simple-minded explanations developed, in many versions, by people in the past. Those who prefer those explanations must still be living in the past, or so convinced of their own "specialness" that they truly believe they could only have originated in "instantaneous creation" by some all-powerful being. If such an all-powerful being exists (which has been neither proved nor disproved and probably never will be), it certainly is just as likely it would have created man by the evolutionary process as by pointing its finger or waving its hand, as many prefer to believe.

If we ever breed or pollute ourselves to extinction it could indicate that the supreme being exists, is tired of us, and is using those methods to get rid of a no longer wanted toy. However, if through exercise of the better human qualities of common sense, cooperation, restraint, and intelligent planning, we are able to extricate ourselves from our



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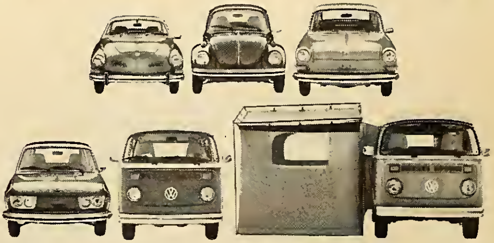

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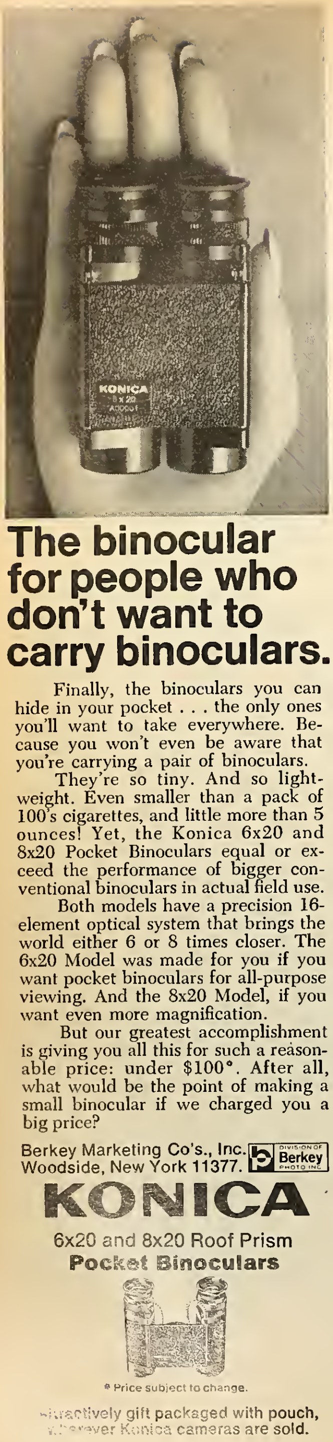

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present environmental mess, it will be a rather convincing demonstration that Mr. Luria's version of "Genesis" is closer to the true one.

J. J. COMBES
Huntington, New York

Scientists and the Bomb

I would like to point out a major error as voiced by Ms. Joyce Kasinsky (October, 1973, "Letters") in reference to her comment on "Hard Times for American Science" [August-September, 1973]. Japan had not capitulated at the time Hiroshima was atomic bombed. As a matter of fact, it was a few days after Nagasaki was leveled that Japan decided to surrender.

I would suggest that Ms. Kasinsky do a bit more historic research before she seeks to brand scientists of any kind as "nuclear barbarians."

ALLEN J. DUFFIS
Landing, New Jersey

Still Struggling for Power

"Man's Age-old Struggle for Power" [October, 1973] presents a well-documented history of past energy crises and their resolutions, but I think the author's optimistic conclusion is not justified. His sanguineness, at a time when we are suffering a serious energy crisis, seems irresponsible.

While much research is being conducted in the areas of solar, thermal, and nuclear power sources, few viable energy schemes have emerged, and Americans must still rely mainly on fossil fuels, which are dwindling at an alarming rate.

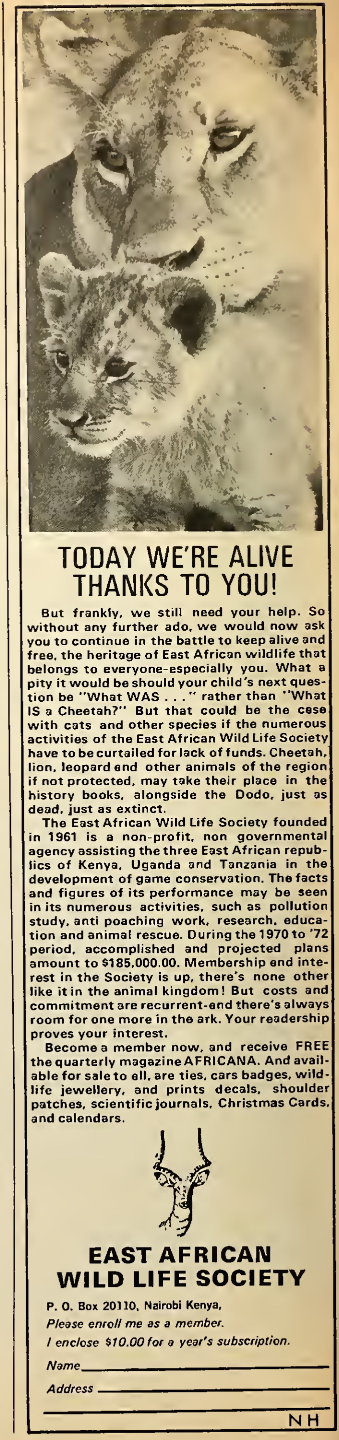
Rather than waiting for science and technology to come up with a solution, it is time for everyone to do his part in helping to alleviate the energy crisis.

ISABEL BERGER
New York, New York

Information Needed

I would appreciate hearing from anyone regarding the effects of pollution on emotions and mental health—letters, case reports, reprints, books, etc.

CLAUDE A. FRAZIER, M.D.
4-C Doctor's Park
Asheville, North Carolina 28801



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But frankly, we still need your help. So without any further ado, we would now ask you to continue in the battle to keep alive and free, the heritage of East African wildlife that belongs to everyone-especially you. What a pity it would be should your child's next question be "What WAS . . ." rather than "What IS a Cheetah?" But that could be the case with cats and other species if the numerous activities of the East African Wild Life Society have to be curtailed for lack of funds. Cheetah, lion, leopard and other animals of the region if not protected, may take their place in the history books, alongside the Dodo, just as dead, just as extinct.

The East African Wild Life Society founded in 1961 is a non-profit, non governmental agency assisting the three East African republics of Kenya, Uganda and Tanzania in the development of game conservation. The facts and figures of its performance may be seen in its numerous activities, such as pollution study, anti poaching work, research, education and animal rescue. During the 1970 to '72 period, accomplished and projected plans amount to $185,000.00. Membership and interest in the Society is up, there's none other like it in the animal kingdom! But costs and commitment are recurrent-and there's always room for one more in the ark. Your readership proves your interest.

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The Want List, as it is known in the publishing trade, covers subjects scheduled for future issues of the magazine and also indicates some of the interesting articles ahead for *Natural History* readers.

Pictures should be sharp, properly exposed, 35mm, or larger, color transparencies. Each item submitted should have the name and address of the sender on it, and nonmembers should include a self-addressed, stamped return envelope. All photographs that are not suitable will be returned promptly.

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Bioluminescence: Any plant or animal, especially deep marine organisms, that generates its own light. Pictures should show the luminescence.

Sandhill crane: The mating dance and other activities *in the wild.* Zoo photographs are not wanted.

Broad-tailed hawk: Nesting, mating, and hunting behavior in the wild.

American alligator: Activities in the wild, especially at the edge of its range in South Carolina.

Primates: Examples of aggression, including sequence shots, in any species of primate in its natural setting.

Chicano graffiti: Examples of artistic and socially significant wall drawings from the Los Angeles area.

Mushroom: A sequence of photographs showing the development of a mushroom in a natural setting. Timing of the sequence should be included.

Miscellany: Interesting photographs taken in the wild of red kangaroos, quail singing, koalas, jacanas, eagles seizing or stealing prey, albino animals.

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KINGDOMS OF THE WESTERN & EASTERN HIMALAYAS • Gilgit - Hunza - Afghanistan - India - Sikkim - Nepal. End September—30 days. Special permits necessary. Kindly apply as early as possible.

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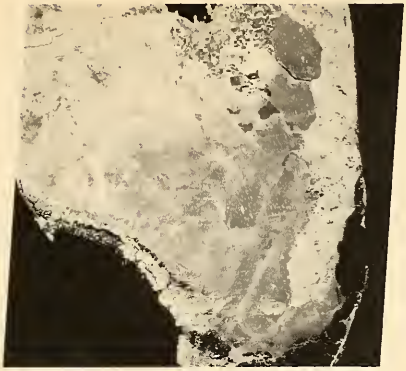
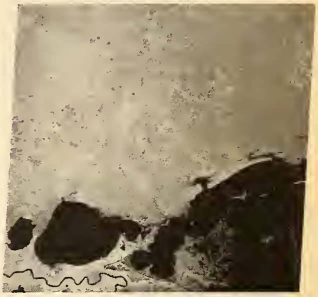
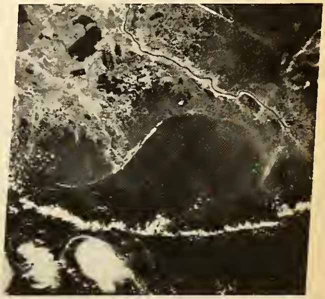

Miami and environs, 22 March 1973

New Orleans and environs, 7 August 1972

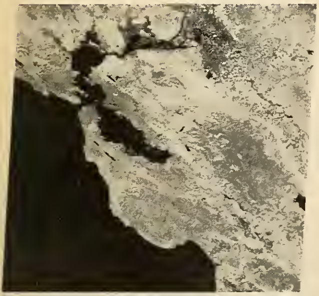



Mississippi delta, 7 August 1972

The U.S. Geological Survey, which runs the EROS program (Earth Resources Observation Systems), points out an opportunity to serve the public interest by calling to your attention that imagery is now available of just about any region on earth, except within some 900 miles of the poles.

Everywhere else, NASA's ERTS (Earth Resources Technology Satellite) goes over every 18 days 567 miles high, looking down in four wavelength bands: 0.5-0.6 μm, 0.6-0.7 μm, 0.7-0.8 μm, and 0.8-1.1 μm. Anybody–grade school teacher, ranch broker, botanist, Cub Scout–with $1.75 to spend can have a 9″ x 9″ print of any place selected. The 9″ x 9″ will encompass 115 miles x 115 miles. Changes may be apparent from the previous pass.

For the sake of preserving the earth's glory, let's learn how to look through mankind's new microscope-in-reverse. Let's assume that if Aristotle and his friends had had even ordinary microscopes, we'd all be happier today.


San Francisco and environs, 4 April 1973

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A quick way to get a look through that great new reverse-microscope in the sky is to phone 605-594-6511 between 7 a.m. and 7 p.m. Central Time. Tell what geographical area interests you and what you have in mind. You will be talking to a helpful, well-informed, and quite real person. His or her hand that isn't holding the telephone will be in contact with heavy computer power.

The computer will even know how much was under cloud each time ERTS passed over the region of interest. It might even report that the area was photographed in 1936 and that, if you'd rather have that black-and-white shot from 5,000 feet instead of infrared "false color" from 567 miles, you can so order. Or you might be told the same place was photographed by a Gemini astronaut with a hand-held camera or by completely automatic equipment from Skylab this year, and how would you like *that?*

The EROS price list reflects just the cost of reproducing the photographs. (The cost of the satellite is more widely shared.) A 40″ x 40″ color enlargement on paper, for example, is priced at $25. To avoid misunderstanding, you can take down the numbers of possibly interesting pictures and check them out on a microfilm browse reader at any of 19 locations in the U.S.A. before placing your order. Black-and-white copy negatives or color internegatives can be ordered if you wish to do your own printing. No copyright worries.

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An article in *American Scientist 61*:175 can take you farther into this fascinating subject. Address reprint requests to Eastman Kodak Company, Dept. 55W, Rochester, N.Y. 14650. But get in touch with EROS, not Kodak, if you want a picture of the old home town from 567 miles up.

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Thanks to cooperating beer and soft drink industries, there are now more than 1200 aluminum collection points in 44 states and the District of Columbia, and the program is growing. This year an estimated 2 *billion* cans will be collected.

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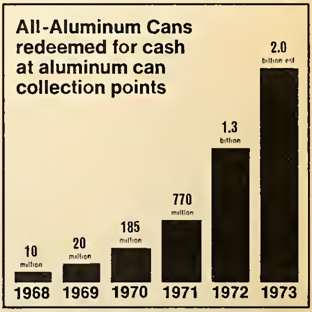
Pure Paper	New Paper Products
Glass	Paving Material Bricks, Block, Structural Shapes

Conserving Resources and Energy The used cans can be converted into new cans and other useful aluminum products, helping to save natural resources. And since it takes less than 1/20 of the energy to make new aluminum from scrap as compared to ore, recycling helps stretch our power supply.

Mining Municipal Waste Litter has been called just the tip of the solid waste iceberg. Reynolds has been working on the bigger "hidden" portion as well—municipal solid waste.

We've teamed with other companies and local and Federal government in the planning of soon-to-be constructed plants in several cities. These will reclaim metals, glass and other usable materials and energy from municipal refuse.



We're also working on the theory that junked automobiles will be less of a problem as more and more high-scrap-value aluminum is used in cars. We've even built a home from recycled materials to demonstrate there are vast new markets for recycled products and that recycled materials can look as good and function as well as products from virgin sources.

For details on the value of aluminum, new and old, or on any of these important projects, write Dr. R. F. Testin, Director, Environmental Planning, Reynolds Metals Company. P.O. Box 27003-LII, Richmond, Va. 23261.

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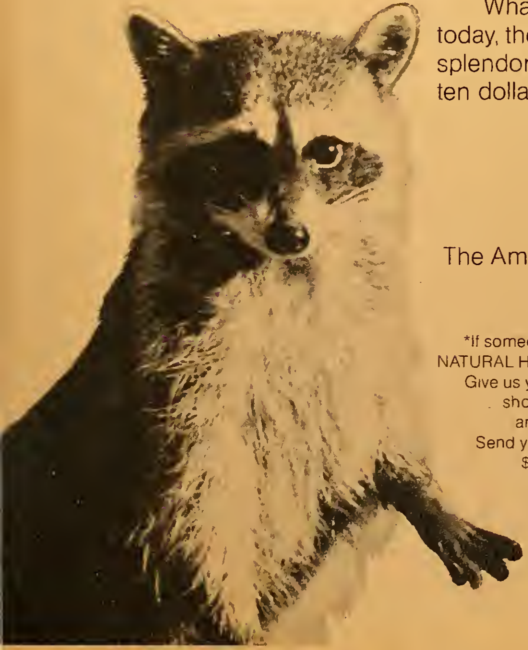

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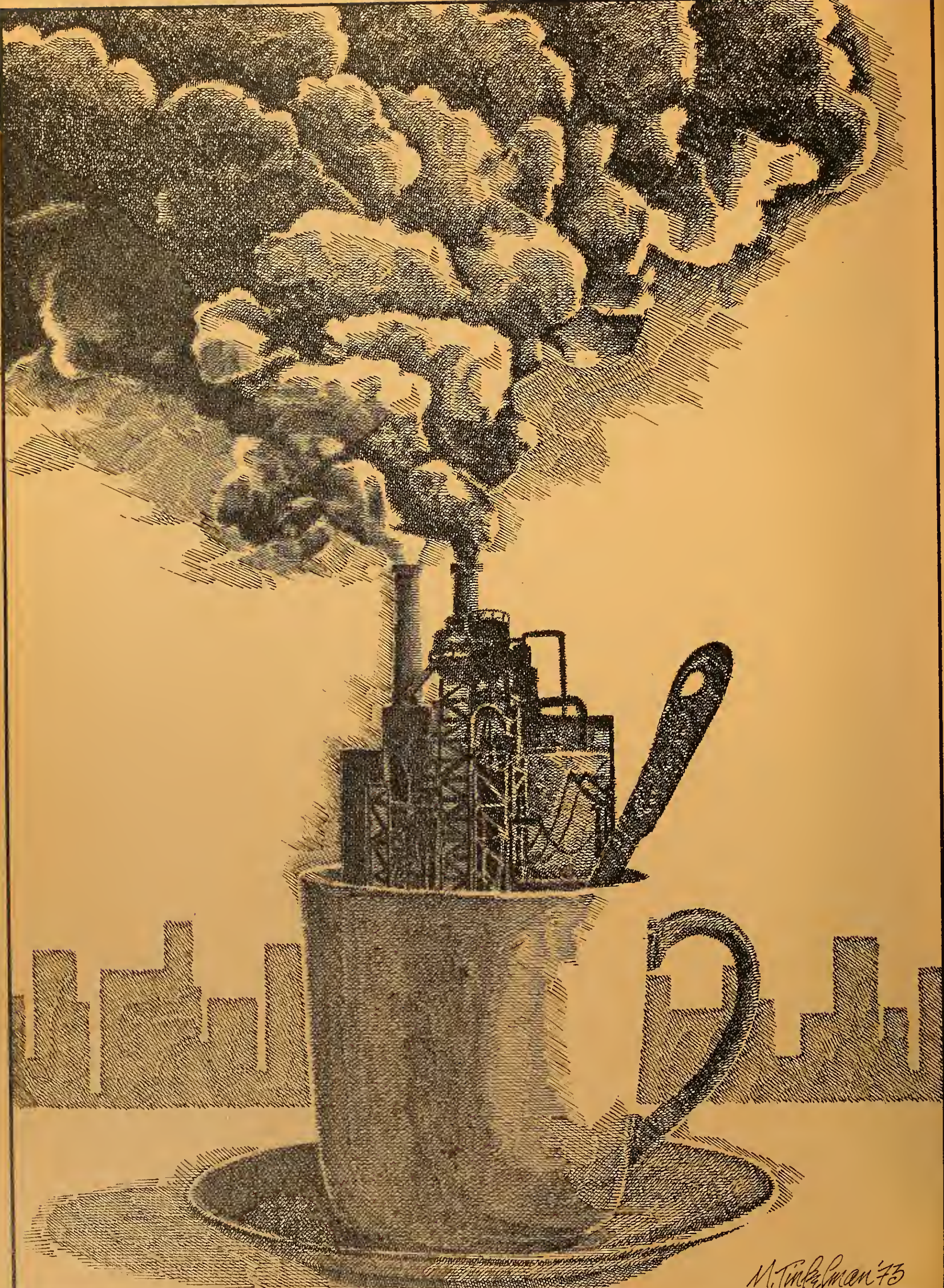

M. Tinkelman '73

Living off the Fuels of the Land

by Eric Hirst

As food prices rise and energy resources dwindle, the counting of calories takes on new significance

We Americans are eating and drinking much of our fossil fuel resources. To put a glass of milk on the table, for example, requires the energy equivalent of half a glass of diesel fuel. To produce a one-pound loaf of bread requires the energy equivalent of two pounds of coal, while a pound of hamburger requires the equivalent of nearly three pounds of coal. This seems like a lot of energy, especially when one realizes that primitive societies produce and distribute food without using any fossil fuels.

In the United States, fuels—coal, oil, natural gas, and uranium—are used to grow, process, transport, wholesale, retail, refrigerate, and cook food. In fact, the fuels consumed in providing and preparing food in 1970 totaled two quadrillion calories, or 12 percent of national energy use. During the same year the average American received and ate 1,500 pounds of food, with an energy content of 3,300 calories per day, making the energy contained in food less than one-sixth the energy required to produce and deliver that food.

Which sectors of the economy account for this considerable energy use? First, farming. Chicken production, for example, looks more like a factory assembly line than a farm. The chickens are grown in densely packed wire cages, mounted in buildings that are artificially lighted, heated, and ventilated. Manure and other wastes are handled mechanically. Chicken feed is manufactured in processing plants from a variety of ingredients, only some of which are grown on farms.

The fuels consumed in growing food products amount to more than 2 percent of the total United States energy budget. About half of this energy is used directly on farms for operating tractors, trucks, and other farm machinery and for irrigating, heating, ventilating, and crop conditioning. The other half is used to produce fertilizers and other agricultural chemicals, feeds, petroleum products, and other farm supplies.

A comparison between the energy content of the food produced and the energy content of the fuels consumed shows that American farms consume more than one calorie of fuel per calorie of food grown. But substituting fuels for manpower results in high labor productivity. Farms in primitive societies, which use no fuels, require six times as much human labor per unit of farm output as American farms.

Large amounts of energy are also consumed in processing food. As more people are concentrated in cities, far from areas where food is grown, there is a greater need for processing. Today about 75 percent of our food is processed before shipment to consumers. Energy is used for boiling, steaming, freezing, drying, and cutting foods and for conveying and packaging finished products. In a cake mix plant, for example, raw ingredients are mechanically conveyed to large tanks, where they are mixed and combined under specified conditions of time, temperature, and pressure. The mix then travels to machines that make plastic bags and fill them with the cake mix. Then the filled bags are mechanically inserted into cardboard boxes, which are packed into cartons and transported to warehouses.

Exclusive of agriculture, food processing consumes an additional 4 percent of the nation's energy budget. This is spent to preserve and protect foods and to convert raw foods into convenience items, such as frozen TV dinners and instant desserts.

To ship food from processors to wholesalers by truck and rail requires energy. Wholesalers use energy to store and ship food to retailers. Retailers use energy to light, heat, and air-condition supermarkets, to store food and advertise it for sale. In all, as much energy is consumed in transporting and selling food as in growing it.

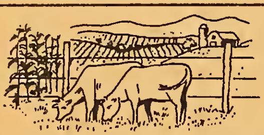
Finally, consumers use energy to carry food from stores to homes by car, to store it in refrigerators and freezers, and to prepare it. Surprisingly, these activities consume almost twice as much energy as growing food and account for nearly a third of the total food energy budget.

What are the returns from these high investments of energy? Six calories of fuel provide only one calorie of food energy; 210 calories of fuel provide one gram of food protein. The energy requirements vary considerably among the different food groups. Processed fruits and vegetables, in particular, require many calories of primary energy per unit of both food energy and protein content. Flour and cereals, fresh vegetables, and dairy products, on the other hand, require relatively small energy inputs per unit of food nutrient. Also, for a given amount of fuel, fresh vegetables provide more protein than meat. In fact, animals, eating corn, soybeans, and other vegetable products, return only about 10 percent of the plant protein as protein in edible meat.

Food-related energy use is growing at an annual rate of about 3.3 percent. Increased population accounts for nearly half this growth, while changes in per capita food consumption account for the rest. These changes—greater use of processed foods and kitchen appliances and greater consumption of meats—all consume more energy. Energy consumption for food may continue to grow at a rate faster than population. Food energy efficiency, however, could be increased in a number of ways. More efficient kitchen appliances, such as smaller, better-insulated refrigerators, offer one possibility. Retailers could close freezers and use less lighting. If homemakers would use more unprocessed foods, there would be an energy savings: it takes three times as much fuel to deliver a unit of food from processing as from agriculture. There are, however, limits to such a shift because much processing is done for health reasons. Finally, substituting vegetable protein for some animal protein would also save energy.

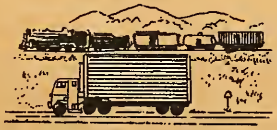
People are increasingly concerned about the shortage of fuels. They are also disturbed by the recent increase in food prices. These concerns should provide sufficient incentive to increase the efficiency of food-related energy use. ☐

Food-related Energy Use in the United States *(in millions of calories)*



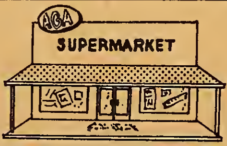
Agriculture
1.5

Food processing
2.7



Transportation
0.2

Wholesale and retail trade
1.3



Homes
2.5

Total
8.2
million calories per person

To bring food from the farm to the table required 8.2 million calories per person in 1963. Numbers indicate the caloric expenditure at each level of the process. The food, in turn, provided each individual with an energy content of 1.1 million calories.

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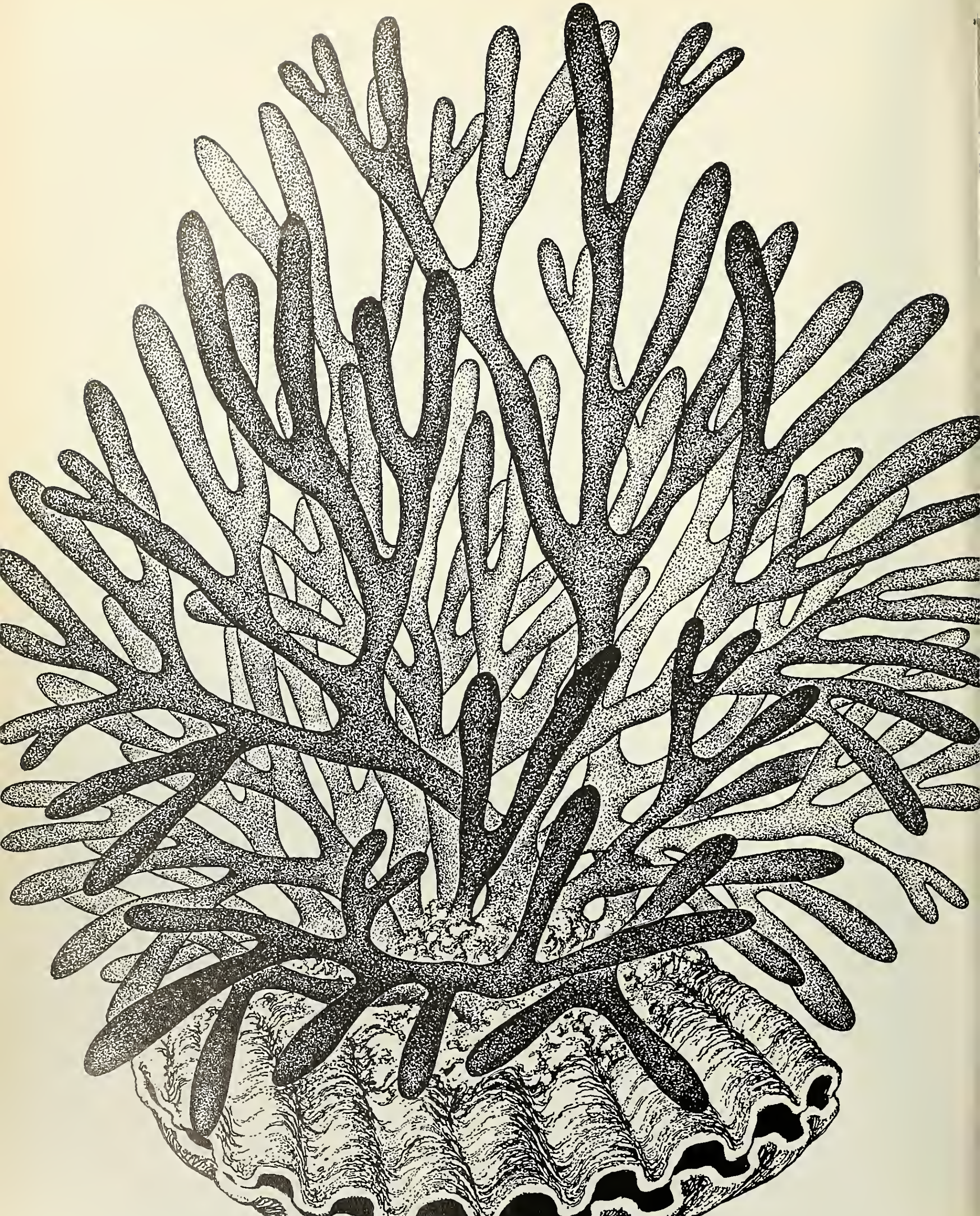

Seaweed Invasion

by Robert Wassman and Joseph Ramus

Neither cold, nor heat,
nor man's ingenuity
has stayed the swift spread
of an alga that disrupts
shellfish beds along
the northeast coast
of the United States

A large green seaweed that formerly could be found in almost all temperate waters of the world except along the northeastern shores of the United States has now come to that region. Elsewhere, the weed *Codium fragile* grows in moderation and is harmless. In its new habitat, however, for reasons not yet understood, the alien species grows at an astonishingly rapid rate, disrupting the environment by driving out native seaweeds and blanketing and destroying prime shellfish beds.

No one knows precisely how *Codium* was introduced to the northeast—perhaps through invisible germlings on seed oysters transported from Washington state or carried inadvertently on ship bottoms from England and France, where the plant also grows. The first specimens in the new locale were found in the winter of 1957 by two collectors of marine fauna at East Marion, Long Island, in near-freezing water. When the sea ice thawed some weeks later, *Codium* was so abundant that it was clear the plant was genuinely established in the area. Long Island fishermen dubbed it "Sputnik weed," suggesting that it might have been dropped by Russian satellites.

Today, sixteen years later, this seaweed, whose slender, cylindrical forked branches have given it the additional common names of "dead man's fingers" and "spaghetti grass," has spread as far north as Boothbay Harbor, Maine, throughout Cape Cod, Rhode Island, Long Island, New Jersey, and was most recently reported as far south as Chesapeake Bay. Although the weed is usually found in quiet, subtidal waters of estuaries and bays, it does not limit itself exclusively to peaceful waters but is also found battling waves and the tidal rip along the shore. In fact, *Codium* grows virtually anywhere it finds a firm surface to which it can attach itself with stability.

The life cycle of this alga begins with a single reproductive swimming cell, or "swarmer," which is released from microscopic reproductive organs. Equipped with two whiplike appendages, the swarmers propel themselves in a breastroke-like manner through the water until contact is made with a stable substrate such as a rock, piling, crab, clam, oyster, mussel, scallop, abandoned beer can, or lost sneaker. When the swarmer has adhered sufficiently to its adopted surface to resist being washed away by tides, currents, and waves, this single cell sends out filaments that form a fuzzy cushion, which constitutes the undifferentiated, or juvenile, phase of development. These filaments continue to grow outward and adhere together through a "contact guidance" mechanism similar to

Codium *attaches to any available solid surface. When it grows on a shellfish, as here on the back of a scallop, it disrupts the animal's life and leads to the creature's doom.*

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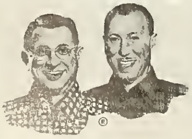

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that responsible for the growth of nerve fibers in animals. In still water, the alga continues to grow but does not differentiate further. In the surge of tides, it differentiates into a second stage of firm, buttonlike primordia. They, in turn, become the slender, cylindrical thallus, or plant body, of the adult weed, which lacks true leaves, stems, and roots and is always forked at the tip. During the growth to maturity, the cell wall formation is incomplete, resulting in millions of nuclei within a single cell and making *Codium* perhaps the largest plant cell known.

The adult plants, which take less than one month to grow, have a pale greenish internal tissue composed of loosely packed, spaghettilike filaments—similar to the juvenile filaments—flanked by a tightly packed dark green outer tissue made up of bulb-shaped units called utricles, on which the reproductive organs develop. These reproductive organs, which produce the swarmer cells, form during the summer months when the water attains a minimum temperature of 55° to 60°F.

The pattern of development appears to be strictly adhered to except during the first burst of growth in the spring, when new branches sometimes emerge at random from portions of older plants, much as young trees occasionally are seen to grow from the trunk of fallen old trees in a forest.

Although *Codium* normally reproduces by means of its swimming cells, the plant, like other seaweeds, can also reproduce through the fragmentation of existing thalli. Thus, bits of adult branches can break off, float away, and attach to new surfaces where they create new stands. In the course of drifting, the fragments may scatter reproductive cells from their reproductive organs along the route, effectively releasing their swarmers in many waters.

Growth occurs from May to November within a wide range of environmental tolerances, reaching a maximum rate of about five inches per month in August when the water is at its warmest. Use of radioactive carbonate permits the determination of the growth rate at which *Codium* transforms, or fixes, inorganic carbon into living matter. It is estimated that a plant weighing about two pounds can fix about one

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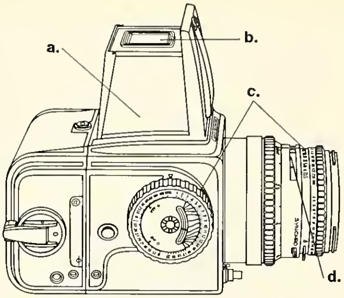

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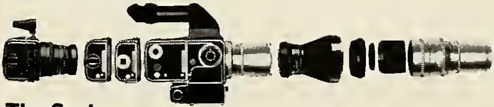

The System

and a half pounds of carbon in one growing season, that is, increase its mass by more than one-half every year.

The reproductive season begins slightly later than the growing season. Some plants, however, bear reproductive organs throughout the entire year.

The bodies of water that *Codium* has infested in the northeast are nearly eutrophic due to the high population density around them. Because of agricultural runoff, the dumping of industrial wastes, septic tanks, and the relatively primitive primary sewage-treatment plants in the area, it is feared that *Codium*'s rapid growth rate might be attributable in part to the enrichment of the water by waste phosphates and nitrates. But the proper enrichment studies to determine the effect of these compounds have not yet been made.

The environmental disruption caused by *Codium* begins with the first step in its development: attachment to a substrate. Although the substrate need only be firm, all too often it turns out to be some variety of shellfish. Shellfish beds are generally found in flat, muddy-bottomed regions, which would otherwise prove uninhabitable for the weeds—the constant shifting of a soft base would bury the plant's germlings or allow them to wash away. But when there are high densities of shellfish on such bottoms, *Codium* swarmers find an extremely stable and amenable home. Small *Codium* plants may initially serve the shellfish as camouflage, just as other seaweeds often do, and in the early stage of development, the weed's primary adverse effect is that the mollusks it attaches to must be cleaned before being marketed. Unlike most seaweeds, however, which are annuals, *Codium* is a perennial. It continues to grow at a rapid rate for several seasons, often attaining wet weights in excess of two pounds. It is when fully grown that *Codium* does its greatest environmental damage.

A large plant is often more than a shellfish can endure, and deleterious effects may result in several ways. Like the first specimens collected off Long Island, which were attached to slipper shells, many of the plants currently washed ashore bring dead shellfish with them. Shellfish growing in unsheltered coastal waters or large bays are prey to the drag generated by wind- or tide-induced water currents acting on the large *Codium* bush on their backs. The mollusks are uprooted from their sand or mud beds or, in the case of mussels, the byssal hairs securing them to rocks are torn, and the animals are set adrift to die stranded on the beach.

The scallop is harmed in a different way. This mollusk moves about by snapping together its two fluted valves. The growth of a large *Codium* plant on one of the valves severely hinders such jet propulsion action, and the animal's chances of survival then become slim. The Niantic River estuary in Connecticut, once a prime producer of scallops, is now virtually barren; *Codium* is thought to have played a major role there in the bivalve's decimation.

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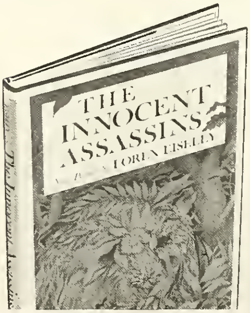
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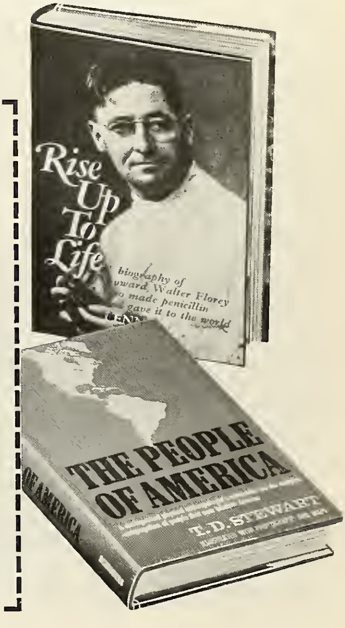
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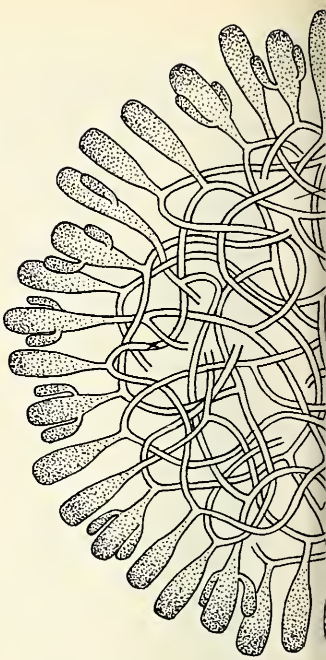
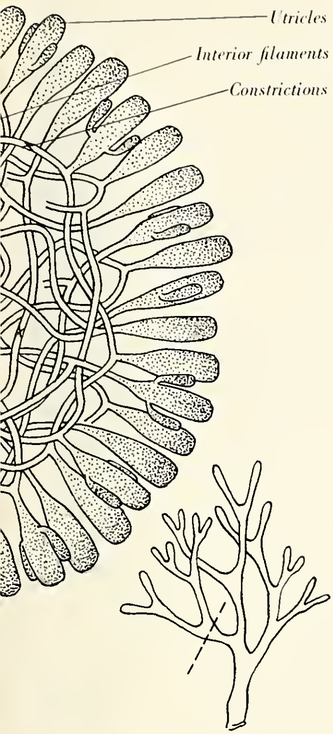


A cross section through a branch of Codium fragile *shows the interior mass of filaments and the exterior layer of utricles, which bear the adult plant's reproductive organs. At constrictions in the filaments, ring-shaped cell wall thickenings prevent loss of vital cellular material when a branch breaks off. The old plant is thus able to survive and regenerate; the fragmented branch can reattach and grow elsewhere.*

Oysters are particularly vulnerable to *Codium*. When a seaweed is photosynthesizing at a rapid rate, the oxygen normally evolved in the process cannot diffuse sufficiently quickly into the surrounding seawater; the gas then accumulates within the plant's tissues. *Codium* is more than 90 percent water and thus normally has a density equal to or slightly less than water. The accu-



mulation of only a small amount of oxygen interstitially causes the plant to become buoyant. *Codium* frequently becomes buoyant enough to pull an oyster out of its bed and carry it away with the currents, which explains why the alga earned the nickname "oyster thief."

The plant's flotation capacity, when combined with its ability to fragment its branches and regenerate its holdfast, seems to be a very significant factor in its rapid dissemination throughout the northeast. By 1961, *Codium* had been accidentally introduced in Cape Cod waters on seed oysters imported from Long Island, but it was not then established in the tidal ponds and estuaries along the Rhode Island coast. At the time, however, free-floating fragments were found in Rhode Island waters; not long afterward that region too was infested. This and other instances of the plant's dispersion implicate fragmentation as a cause of *Codium*'s rapid spread to new localities.

Quantitative studies show that fragmentation is greatest during the winter months when the water tem-

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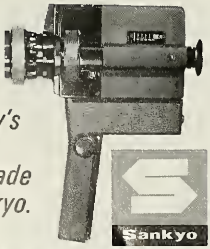

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perature is at its lowest point. Low temperatures induce the formation of constrictions of the upright axes, and these serve as areas of weakness in the fragmentation process. Winter fragmentation is one factor that enables *Codium* to disperse during that season and thus gain an edge on other seaweed species in the spring bloom.

The plant's fragmentation capacity results from an effective and rapid wound-healing mechanism analogous to the clotting of blood in animals. When the thallus is broken, cellular debris—nuclei, chloroplasts, mitochondria, and other particulate constituents of the intracellular milieu—accumulates at internal, ring-shaped cell wall thickenings, which are preformed in the plant's spaghettilike interior tissue, and blocks off the outward flow of cytoplasm. This minimizes the loss of vital components and "trauma," permitting the plant to survive and regenerate.

Like other green plants, a seaweed is dependent upon sunlight to drive the process of photosynthesis, which converts inorganic carbon dioxide into organic compounds with the concomitant release of oxygen to the environment. The energy provided by sunlight is stored biologically by this process, and the release of this stored energy by respiration drives the basal life functions. Any excess of production over the respiratory demands is either used for growth or stored for times when the sunlight is insufficient to maintain photosynthesis at a rate greater than the respiratory demands.

Scattering and absorption of light lower the total available light energy proportional to the depth of the water. Eventually a critical point, or "compensation depth," is reached at which there is only enough light energy to enable a plant to meet its basic respiratory requirements. Thus, at the compensation depth no net growth can occur, and below that point, the alga cannot exist. Although the absolute depth of this critical point may vary with such oceanographic conditions as turbidity, the minimum amount of light a plant requires for survival remains constant.

Codium has been observed to grow at compensation depths of from sixteen to thirty feet at different locations and in different condi-

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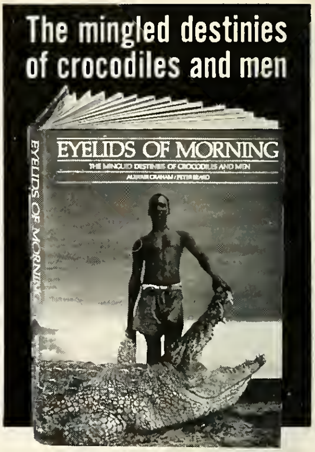
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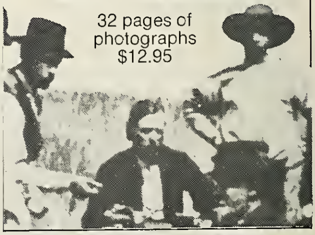

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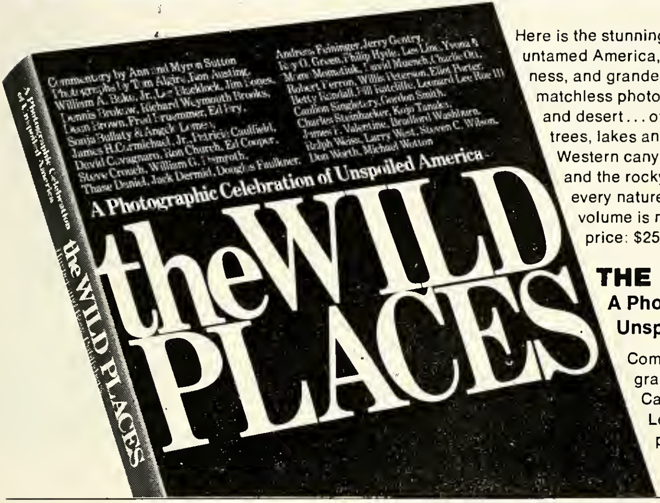
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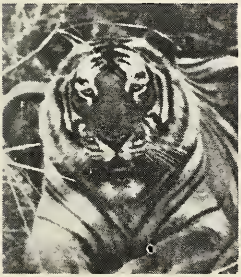

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tions of turbidity. An underwater solar illuminance meter showed, however, that these depths were identical in terms of available light energy. Shellfish beds planted below this effective compensation depth can therefore be presumed to be free from the threat of infestation by the weed. But, *Codium* does not generally seem to grow all the way down to its true compensation depth. This may be the result of competition for available substrate with better-adapted species, the reduction of light caused by shading from other plants and the contour of the bottom, or the diminished viability of swarmers in low-intensity light.

Physiological measurements on individual plants grown at different depths show that with decreasing light intensity at increasing depths, the amount of chlorophyll is increased and the amount of stored starch is decreased. That may be teleologically interpreted as an attempt by the seaweed to increase its photosynthetic capacity as light becomes limiting. Since this is a hopeless cause, the plant is forced to consume its energy reserves.

What can be done to check the further spread of this weed invader, control its growth, or remove it entirely where it has already established a foothold? As an alien plant in the northeast, it has no natural local predators that can be used for biological control. The green sea urchin does, however, graze on the weed in Long Island Sound when its preferred diet of kelp is unavailable. These animals have been imported and released on a rocky, *Codium*-covered shelf at Exton's Reef, near the town of Branford, Connecticut, in an experiment to see whether they will eat the seaweed there. In other experiments, quicklime pellets, which sink to the bottom where they destroy the *Codium*, are also being tried. Quicklime reacts with water, and in the hydration, or slaking process, heat is released. The heat burns anything that comes into contact with the slaked lime. Oysters and other mollusks are unaffected because they close their valves, sealing themselves inside an impenetrable encasement.

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been constructed at strategic shellfish beds to protect them from clumps of loose *Codium* that roll around the sea bottom like tumbleweed. And stands of the alga are dredged and harvested in winter or dragged with chains to break the plant off its substrate when it is brittle.

Despite all these efforts, *Codium* is probably in the waters of the northeastern United States to stay. In that case the best way to insure its control, if not its ultimate disappearance, is to find a market for it. Most of the plant is water, and although the starch it contains is biochemically similar to potato starch, it makes up only about 1 to 2 percent of the dry weight. *Codium*'s cell walls are almost pure mannan, a polysaccharide that we cannot digest. Its potential as a food for humans therefore seems extremely limited. But it might be developed as silage, fodder, or a soil conditioner to supplement substances presently in use that are either becoming too expensive or too scarce. ☐

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The Glory That Was Jerusalem

Recent archeological digs and ancient writings confirm that Jews fought, and lost, one of their most important battles 1,903 years ago

by Christopher L. Hallowell

photographs by Ted Spiegel

The year A.D. 70 marked one of many turning points in Jerusalem's glorious but bloody history since its settlement some 2,000 years earlier. In that year four Roman legions under Titus, the commander of Roman forces in Judaea, plundered and destroyed Herod the Great's Temple and crushed the Jewish rebellion against Roman occupation that had erupted in the year 66.

Titus's efforts to defeat the Jews were determined and efficient. Bit by bit, over a six-month period, he broke them down physically and psychologically, tumbling down the walls of Jerusalem and slaughtering its inhabitants. His legions were well equipped with swords, spears, bows, battering rams, and the glory of Rome, while the Jews were ill equipped, decimated, starving, and weakened by internal dissent.

Three months after Titus attacked, his legions had crashed through two city walls and were at the base of the Temple to which the rebelling Jews had retreated and which they were using as a fortress, as well as a place of worship. The Jews knew that if the Romans broke into the huge Temple complex, the battle would be lost. In an effort to breach the Temple walls, the Romans began to construct great wooden towers, but the Jewish defenders of the Temple rained arrows down upon them. The fighting was intense, but at the last moment, the Jews managed to destroy the towers.

Titus then changed his course of action and decided to starve the Jews out. Completely surrounding the city with his legions, he waited for the rebels to surrender. As the months went by, the food supply and morale dwindled sharply inside the Temple. Those who attempted to desert were tortured to death by the Jewish soldiers. Many Jews starved to death, and even those who had managed to hoard food soon lost it to marauders.

Most of the Jews who attempted to sneak past the Roman lines to search for food were captured and killed, often by crucifixion. At one point, the Romans took so many prisoners that there was not enough wood to replace the crosses that Titus had erected at the base of the Temple walls in full view of the Jews within.

As the siege weakened the Jews, Titus's legions again attempted to breach the walls, this time by prying away the great stones. That failing, they burned down the Temple's silver-plated gates and, in hand-to-hand combat, forced their way into the outer parts of the Temple complex. Whereupon the Jews retreated to the gold-plated Sanctuary, the Temple's holiest sanctum.

Not wanting to destroy the Sanctuary, Titus ordered his soldiers to surround it, forcing the Jews within to surrender. But one of his men, excited by the impending victory, hurled a piece of burning wood into the Sanctuary and the whole structure was soon ablaze. Of this moment, the first-century A.D. Jewish historian Flavius Josephus writes:

> The Temple Hill, enveloped in flames from top to bottom, appeared to be boiling up from its very roots; yet the sea of flame was nothing to the ocean of blood, or the company of killers to the armies of killed; nowhere could the ground be seen between the corpses . . . soldiers climbed over the heaps of bodies as they chased the fugitives.

Within a few days the entire Temple was destroyed, and much of Jerusalem was nothing but rubble and ashes.

The roots of the rebellion that culminated in Jerusalem's fall and the Temple's destruction had been laid in 63 B.C. In that year, the Roman general Pompey swept up the eastern coast of the Mediterranean, and through a series of clever political maneuvers, added Judaea to the Roman Empire.

In the years that followed, resentment against foreign rule increased, until sporadic rebellions erupted early in the first century A.D. According to some theologians, Jesus may have been the leader of one of the rebellious factions. After several humiliating defeats, the Romans decided to subdue the Jews once and for all and sent Titus and his legions to Jerusalem.

After the destruction of the Temple, Judaism's center, the Romans built a garrison town in the midst of Jerusalem's ruins. Throughout Judaea, however, Jewish guerrilla bands continued to strike out against the Roman legions. In A.D. 132, the guerrillas, under the leadership of Bar Kokba, captured the city. Three years later, a strong Roman force quelled the revolt, and the emperor Hadrian ordered the obliteration of Jerusalem. Upon its site, he constructed a smaller city named Aelia Capitolina.

Jerusalem has been plundered and sacked many times throughout its history. Before the coming of the Romans, the city had been occupied by the Egyptians, Assyrians, Babylonians, Persians, and Seleucids. The Romans were followed by the Moslem Arabs who were followed, in turn, by the Crusaders, the Mamelukes, and the Ottomans. Yet, throughout the conquests and the political intrigues that led up to them, and despite the bloodshed during and after them, Jerusalem has remained a holy city for three religions—Judaism, Christianity, and Islam.

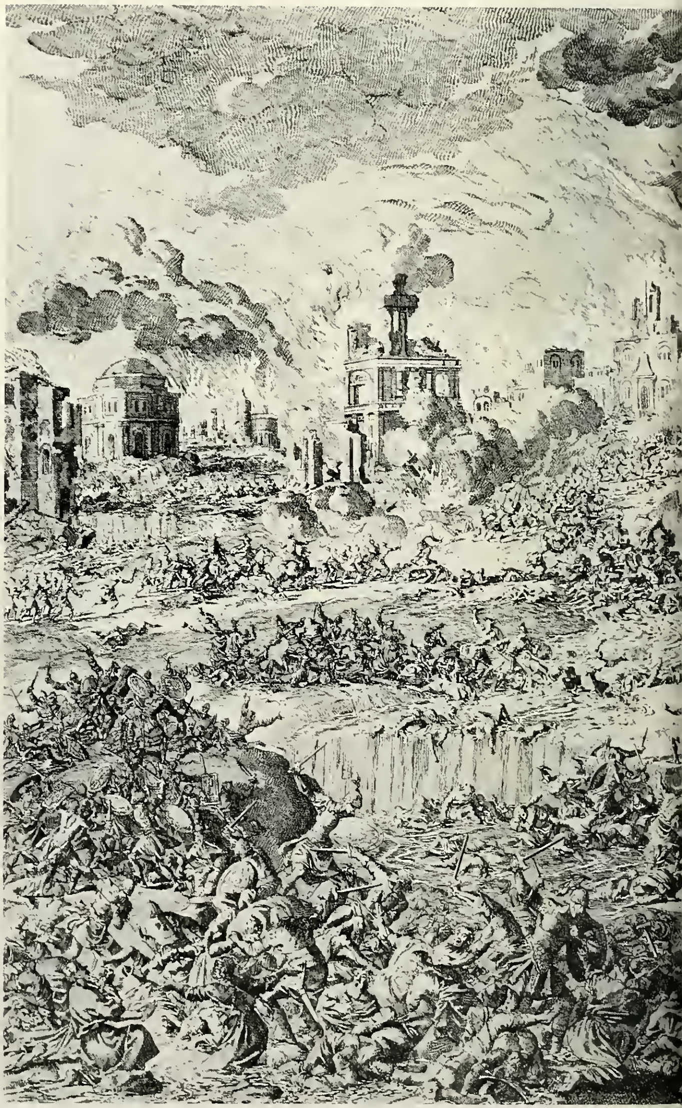
Jews have considered Jerusalem to be the center of the universe, with a heavenly city suspended over the earthly one. It was here that Solomon, son of King David, built the First Temple in the middle of the tenth century B.C.: "And, behold, I purpose to build an house unto the name of the Lord my God. . ." (1 Kings 5:5). Christians consider Jerusalem a sacred city because Christ was crucified and resurrected here. And Mohammed, the founder of Islam, is said to have ascended to heaven upon a winged horse from the top of Mount Moriah, where the First Temple was located before its partial destruction by the Babylonians in the sixth century B.C.

How the city first came to be sacred is a mystery lost in time. Ancient rabbis wrote that God created the world at Jerusalem and that from its soil He created the first man. Archeological findings suggest that Jerusalem, situated in the Judaean hills of what is now central Israel, was first settled by seminomadic tribes. Wandering about the dry and rugged hills under the scorching sun, they may have been attracted to the site by the area's sole source of water, the Gihon Spring, located a few hundred yards south of today's city. Even now, water bubbles out of the depths of the spring at three-hour intervals.

The many historical and religious figures, the prophets and conquerors—Abraham, Joshua, David, Solomon, Nebuchadnezzar, Alexander, and Constantine the Great—who came to the city gave Jerusalem an air of mystery and drama that has endured over the centuries.

Despite Jerusalem's cloudy past, Israeli archeologists have pieced together some of the city's dramatic first-century A.D. history through excavation projects initiated after the end of the Six Day War in 1967. Near the retaining wall of Herod's Temple, archeologists under Prof. Benjamin Mazar of the Hebrew University are clearing away the rubble of centuries to reveal the exterior portions of the Temple complex. In the Jewish Quarter of the Old City, much of which was destroyed in the 1948 War of Independence, an archeological team led by Prof. Nahman Avigad, also of the Hebrew University, is exploring each foundation, cellar hole, and artifact revealed by bulldozers clearing the area for housing projects.

The religious origins of Herod's Temple go back to the middle of the tenth century B.C., when Solomon constructed the First Temple, considered by Jews of the time to be God's chosen house. Located on Mount Moriah, actually a hill overlooking three valleys just east of today's city, the Temple was made of thick stones and richly carved cedar from Lebanon.



"And he [Solomon] carved all the walls of the house round about with carved figures of cherubims and palm trees and open flowers, within and without.

"And the floor of the house he overlaid with gold, within and without" (1 Kings 6:29–30).

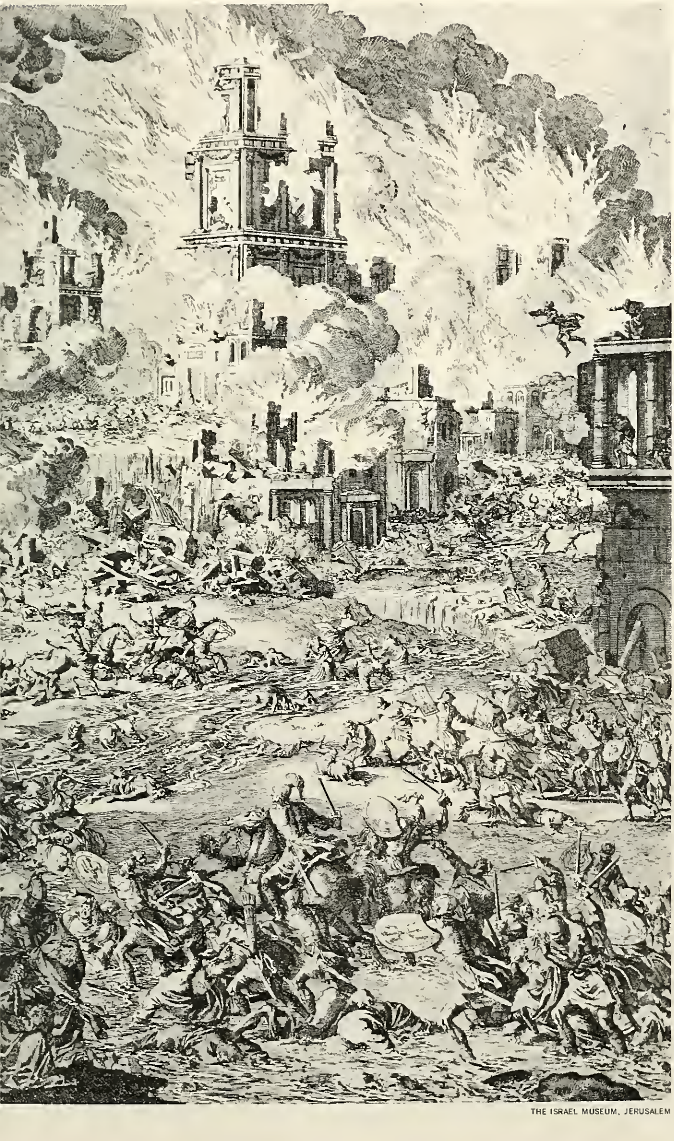
The most sacred part of the Temple was the inner chamber, which held the Ark of the Covenant, a carved chest containing the Jewish Laws, including the Ten Commandments that Moses had brought down from Mount Sinai three centuries earlier.

The Temple, together with the Ark, was destroyed in 586 B.C. by the Babylonians, who exiled many Jews to Babylon. When they struggled back fifty years later, they built the Second Temple, but that too was ransacked and plundered. Finally almost five centuries later, it was rebuilt by Herod the Great.

Herod was not a Jew, but through his dealings with the Romans he was proclaimed king of Judaea in 37 B.C. He proved to be a brilliant but eccentric ruler, who murdered his wife and three of his sons because of their political leanings. Over the course of his more than 30-year reign, he became a prolific builder, and the Temple, which he began to rebuild in 20 B.C., reflected his enthusiasm for creating elaborate monuments.

His workmen first poured tons of fill into the Tyropoeon Valley to the southwest of the destroyed Second Temple and constructed rectangular walls some 300 by 400 yards to hold the fill in place. Today these walls vary in height from 50 feet on the north to 125 feet on the south. On the mound of fill, with the main part of Jerusalem on the west and the Mount of Olives to the east, Herod rebuilt and greatly enlarged the Second Temple.

Most descriptions of the Temple have come down to us from Josephus. He was an upper-class Jew and one-time governor of Galilee who witnessed the Temple's destruction from the Roman camp, having turned traitor during the course of the Jewish rebellion. Although his writings provide much valuable information on Jerusalem in the first century, he had a penchant for exaggeration. He also had an ax to grind against the rebelling Jews, most of whom, unlike him, were not of the Jewish elite. Consequently, many of his descriptions have been disputed by both historians and archeologists. However, some findings near the Temple Mount and in the Jewish Quarter of the Old City, as well as at other



THE ISRAEL MUSEUM, JERUSALEM

An anonymous eighteenth-century Dutch artist with an eye for the dramatic etched the destruction of the Second Temple by Titus's legions.

archeological sites in Israel, have confirmed Josephus's observations.

The inner Temple, separated from the rest of the structure by a 60-foot-high wall, was dominated by the partially gold-plated Sanctuary, the symbolic location of the Ark of the Covenant. According to Josephus, the Sanctuary was a glorious sight.

> Overlaid all round with stout plates of gold, in the first rays of the sun it reflected so fierce a blaze of fire that those who endeavoured to look at it were forced to turn away as if they had looked straight at the sun. To strangers as they approached it seemed in the distance like a mountain covered with snow; for any part not covered with gold was a dazzling white.

The court of the Israelites, where Jewish priests performed animal sacrifices, surrounded the Sanctuary. The Temple's vast treasures were concealed in vaults beneath this court. Soon after Titus's legions burned down the Temple gates, they discovered the treasures. While some slaughtered the defending Jews, others carried away the wealth.

The thousands of worshipers who made the pilgrimage to the Temple from every part of Judaea first entered the Temple's lower court to the south of the Sanctuary. Here they waited for the priests to sacrifice the sheep and goats they had brought with them. A portico, which Josephus called the Colonnade of the King, stood at the southern edge of the lower court. It was supported by 162 Corinthian columns, each so large that three men standing with arms outstretched could not encircle one. Moneylenders competed for profits amidst the columns. Disgusted by the profiteering in a place of worship, Jesus overturned their tables, much to the wrath of the priests.

For centuries after its destruction by the Romans, all that could be seen of the remains of the Temple were its retaining walls. So strong were the feelings of Jews about the loss of the Temple that they prayed at the foot of these walls. Over the years, the Western, or Wailing, Wall, a 150-foot-long section of the western retaining wall, replaced the Temple as Judaism's most sacred spot. Jews from every part of the world have traveled to Jerusalem to bewail the loss of the Temple and to pray at the Wall for God's return to his house. Some Jews write their prayers on pieces of paper, which they lodge between the cracks in the stones, believing that God visits the Wall every night to read them.

According to some Jews, the stones of the Western Wall are particularly sacred because they were put in place by Jewish laborers hired by Herod, whereas other parts of the retaining walls were built by non-Jewish laborers. And more importantly, the Wailing Wall, located as it is in the center of the western wall, is closer to the supposed site of the Second Temple's Sanctuary than any other parts of the retaining walls.

Jewish legend states that the dew that forms on the stones of the Western Wall at night are tears shed by the stones for the Jews exiled after the Temple's destruction. Neatly reshaping the legend to fit the years since 1967, some Israelis say the dewdrops are tears of joy that Jews can now pray at the Wall without harassment by the former non-Jewish controlling powers.

Were it not for the strength of tradition, the recently discovered remains of the Temple area might take on the same sacredness as the Western Wall. To the uninitiated, the foundation walls, the deep pits, the columns sprawled over the dusty ground, and the huge Herodian stones scattered here and there, spell confusion. Even Israeli archeologists working on the site are challenged to interpret the foundations, cisterns, floors, and artifacts. Centuries of construction took place in the area. Each conquering civilization destroyed the buildings of the vanquished, then built its own buildings on the ruined foundations and over the rubble-strewn floors.

After the Romans leveled Herod's Temple and the surrounding area, they occupied the site for two centuries. The once glorious city of Jerusalem became no more than a quiet garrison town housing the Tenth Legion in buildings made of bricks. Many of these bricks, stamped with the legion's inscription, *Legio X Fretensis*, have turned up in the debris at the base of the western and southern retaining walls of the temple. Aside from a few statues, only a steam bath near the western wall remains from the Roman period, an indication, perhaps, of the casual life led by Roman soldiers after they defeated the Jews.

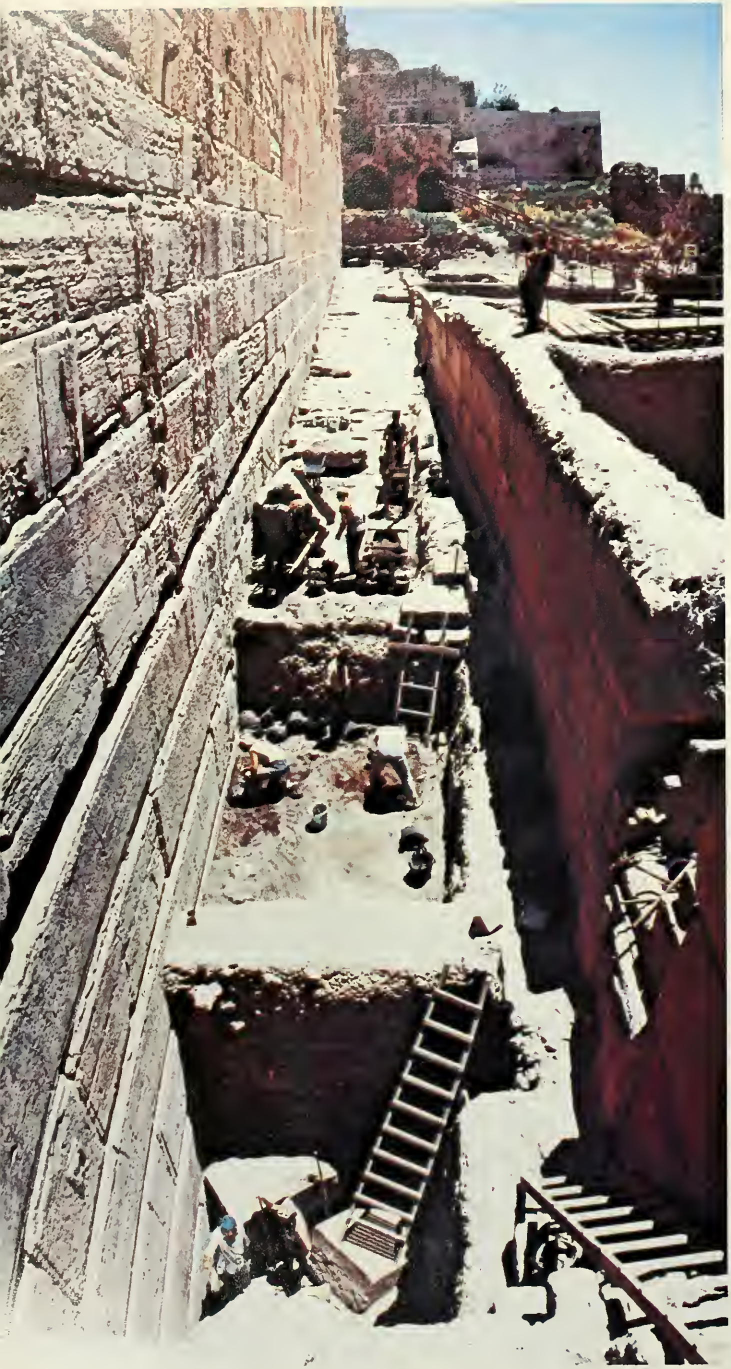
Jewish prayer books, many containing different liturgies of the various areas from which Jews emigrated to Israel, collect at the Western Wall for worshipers to use.

Early in the fourth century, the emperor Constantine shifted the seat of the Roman Empire east. He founded the new capital near where the Greek city of Byzantium had stood and called it New Rome. The city soon became known as Constantinople. Today it is Istanbul. Constantine proclaimed Christianity the official religion of the empire, and he and his mother, Empress Helena, both devout believers, established Jerusalem as a Christian center and built numerous shrines and churches honoring the new religion. The marks of Byzantium were left in the Temple Mount area in the form of foundations, walls, arches, and beautiful mosaic floors.

During the Byzantine rule of Jerusalem, another religion, Islam, was growing to the south. Gradually the Moslems took control of the Arabian peninsula and spread the teachings of Mohammed. In their efforts to gain new territory in the name of Allah, they moved northward, and in the year 638, they reached Jerusalem, which they controlled for the next four centuries.

During their rule, the Omayyad period, they built the Dome of the Rock, the mosque that today dominates the area within the Temple's retaining walls. Moslems believe it is from this spot that Mohammed ascended to heaven on a winged

The Kidron Valley lies between the Russian Orthodox Church of Mary Magdalene, foreground, situated on the Mount of Olives, and the Moslem Dome of the Rock, located on the site of Herod's Temple in Jerusalem.

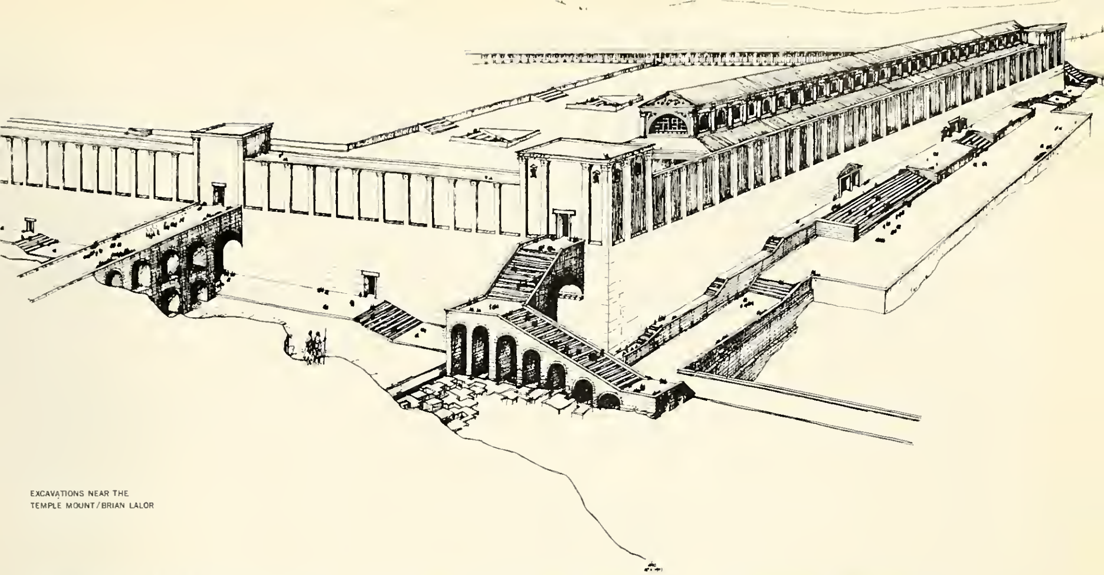


horse. Outside of the Temple Mount, but adjacent to the western and southern retaining walls, the Moslems constructed three large buildings. Archeologists have uncovered remains of the massive walls of these buildings made out of huge stones from Herodian times. These walls must have formed buildings of some importance; one of them may have been a palace. Ordinarily, palaces and other significant structures are built to be highly visible, with large courtyards and open areas. Yet these buildings were constructed right next to the towering Temple retaining walls, separated from them by no more than fourteen feet.

When the excavations began in 1967, archeologists dug down through the Moslem, Byzantine, and Roman ruins before coming across signs of the Jewish rebellion. Lying in the debris were numerous coins stamped with the Hebrew inscriptions "Year One," "Year Two," "Year Three," and so forth. The Year One coins were minted in A.D. 66, when the Jews began their revolt. Significantly, with each succeeding year of the rebellion, fewer coins marked with the appropriate year appeared, a sign perhaps that as the struggle heightened and became more desperate, the Jews turned away from less vital concerns to defend themselves against the Roman onslaught.

Many of these coins, together with numerous oil lamps and pottery shards, were scattered in the six-foot layer of debris from the Temple's destruction, which covered the Herodian pavements along the western and southern retaining

While excavating along the southern wall of the Temple Mount, left, archeologists uncovered huge stones that fell when the Temple was destroyed. The wall at right was built by the Moslems and may have been part of a palace.



EXCAVATIONS NEAR THE TEMPLE MOUNT/BRIAN LALOR

Archeological evidence enabled architects to sketch portions of Herod's Temple. The "Colonnade of the King" runs along the southern retaining wall, and Robinson's Arch is located at the wall's southwestern corner.

walls. For 1,900 years since the end of the Jewish rebellion, the rubble concealed the fine workmanship that went into Herod's Temple and which was revealed for the first time only several years ago. The huge limestone rectangles, some as much as 30 feet long and 15 feet thick, were bossed and fitted without the use of mortar. For maximum retaining strength against the tons of fill inside the walls, each course of stones had been set inward several inches, thus giving the entire wall the appearance of leaning. During the first century, the newly quarried limestone must have been pure white. Josephus mistakenly says that some parts of the Temple were constructed of glistening marble.

The most telling evidence of the Temple's destruction are the huge Herodian stones from the topmost level of the southern wall found lying on the pavement 125 feet below. These were pushed off either by the Jewish defenders in an effort to prevent the Romans below from battering down the wall or by the Romans after they overran the Temple.

One of the most dramatic finds of the 1969–70 excavation season was one of these stones with a recess and a Hebrew inscription carved into it. The inscription, part of which is missing, reads that the ram's horn, or shofar, was blown from this spot. The stone apparently fell from the southwest corner of the Temple Mount. This is mentioned by Josephus, who also wrote that priests mounted the wall to blow the horn announcing the beginning and end of each Sabbath.

Among the fallen blocks on the pavement, ornamental stone fragments intricately carved with leaves, rosettes, grape clusters, and swastikas, the latter a remnant of Hellenistic design, tell of the detail and glory of the destroyed Temple.

Until 1967, the area south of the southern retaining wall was a gentle grassy slope with no hint of the underlying complex architectural remains. As archeologists scraped away the earth, they uncovered remains that helped them determine the Temple area's design. The probing between the walls of the huge Omayyad foundations revealed a 50-foot-wide Herodian plaza south of the southern wall. The thousands of pilgrims coming to Jerusalem may have gathered here before ascending to the Temple to worship. Following Jewish law, they probably underwent ritual purification, bathing in the water that collected in small hollows carved into the limestone bedrock under the plaza.

Ascent to the Temple was by way of a broad limestone stairway, which led from the plaza to gates in the southern wall. The faint outline of the now blocked-off gates can be seen today. The Mishna, the part of the Talmud that contains the Oral Law, makes passing reference to priests climbing this 70-yard-wide stairway to enter the Temple.

Josephus wrote that priests also entered and left the Temple through their own secret passage. In 1971 archeologists came upon what they believe to be one end of this passage, located near the foot of the stairway. Today it can be seen as a narrow opening—no more than two feet wide—hewn into the bedrock and leading toward the southern wall. Archeologists believe it ends up underneath the site of the former Temple Sanctuary, now occupied by the Dome of the Rock.

Several similar passages exist along the southern wall, but they have not been explored to their full length. Because the inside of the Temple Mount is sacred to the Moslems, they object on religious grounds to their further excavation. The El-Aksa mosque is situated directly above the southern wall, and its administrators have sealed up the passages from the basement of the mosque in order to prevent Israeli archeologists from encroaching upon their sacred ground. For the moment, however, archeologists are occupied with excavating on the outside of the walls, and the potentially explosive matter is in abeyance.

In 1971 the excavating teams turned their attention to the area just north of the southwest corner of the retaining walls—a hodgepodge of walls, tombs, cisterns, and channels dating back to the seventh century B.C. Deep pits that were once cisterns are everywhere, and channels that carried water to and from them weave around ancient foundations. Nearby, the dark entrances of ancient tombs, long since robbed, add to the area's mazelike appearance. One of the highlights of the excavations in this area has been the settlement of the controversy surrounding Robinson's Arch. First discovered in 1852 by a biblical scholar named Edward Robinson, the finding consisted of the remains of an arch jutting out of the western wall about fourteen yards north of its southern end.

Until just a few years ago, archeologists had assumed that the arch was part of a roadway connecting the Temple with the Upper City to the west, now the Jewish Quarter of the Old City. In the 1870s, when an archeologist named Charles Warren discovered a stone pier to the west of the arch, the roadway theory became a near certainty. This belief was adhered to even though Josephus made no mention of a bridge in the area (suggesting that archeologists in the past took Josephus's writing with a grain of salt). He did mention, however, a number of steps leading from the Temple down into the unfilled portion of the Tyropoeon Valley to the south.

Putting together the various bits of information, the present archeological team has reached the conclusion that Robinson's Arch was actually part of a 50-foot-wide stairway that turned a right angle at the pier and opened onto a Herodian street built along the floor of the Tyropoeon Valley. The stairway led to what was probably an enormous gate that opened into the Temple's commercial section underneath the southern portico.

While excavating under the arch during the 1969–70 season, an Old Testament passage found inscribed on one of the stones of the wall struck emotional chords in the hearts of devout Jews. The passage reads, "And when ye see this, your heart shall rejoice, and your bones shall flourish like an herb. . ." (Isaiah 66:14). Professor Mazar believes that the passage was carved during the fourth century when the Jews began rebuilding the Temple under the emperor Julian. During his short reign (three years) Julian issued an edict of toleration, but with his death in A.D. 363, work on the Temple came to a halt. Since the Temple's destruction three centuries before, Jews had waited and prayed for the opportunity to rebuild it. When Julian gave them the chance to do so, they were understandably enthusiastic, as reflected by the inscription.

As the excavations continue, more details of Jerusalem in the first century and of the outer sections of Herod's Temple are coming to light. Some of the finds, such as the huge cisterns, the underground chambers, and the concealed passages are mysterious in nature. Others reveal the glory of the Temple's massive architecture and rich decor. More significantly, however, some of the discoveries permit us to better understand the struggles of the period and the reasons for Jerusalem's eternal glory. As the rubble of the past centuries, be it of Jewish, Christian, or Islamic origin, is scraped away to reveal definite forms, archeologists and laymen alike feel the emotional impact of the findings.

For example, the 1970 discovery of the "burned house" in the Jewish quarter of the Old City, west of the Wailing Wall, told a definite story of one point in Jewish history. The heat of an intense fire had apparently caved in the walls of the house, and the remaining floors of its lower levels were covered with ashes and bits of charred wood. The coins found among the debris indicated to archeologists that the fire occurred in A.D. 70. Josephus wrote that this section of Jerusalem was sacked and burned immediately after the destruction of the Temple.

Each year Jews converge on the Wailing Wall to celebrate Jerusalem Day, the third day of the Six Day War, when they gained control of the Wall. The anniversary falls in May or June as determined by the Jewish calendar.

A stone weight marked with the name Bar Kathros, apparently the owner of the house, was found lying on one of the floors. The Babylonian Talmud mentions the house of Kathros, an upper-class Jewish family who lived in this area of the city during the Second Temple period.

Prof. Nahman Avigad described his feelings, as well as those of other archeologists, when the house was discovered. There in front of them, said Avigad, was evidence that not only enabled them to substantiate the writings of Josephus but also permitted them to picture in their imaginations the destruction of the Upper City and the slaughter of the Jews.

The recent discoveries are not only bringing the struggles and glories of Jerusalem's past to our knowledge; they may also result in an updated version of the city's history. Through vague accounts and legends, historians and archeologists are aware that much remains to be discovered concerning Jerusalem in the first century. Historical proof of the legends may lie buried under the tons of rubble still to be excavated. In a more spiritual sense, the excavations in Jerusalem, and in other parts of Israel, are creating a new Bible. The impact of foundations, tombs, and artifacts is immediate and irrefutable. Contrary to the poetic, historical drama of the Bible, the excavation findings tell a more substantial, albeit, more rigid, story of the land's past. □

The Japanese Art of Tattooing

by Donald Richie

Once the brand of the criminal, irezumi *has evolved into a stylized form of body decoration*

photographs by George and Claire Louden

Tattooing in Japan is an art that has grown out of a long and complex tradition. A strong and distinctive style has been achieved, a number of tattoo masters continue to practice, and there are, even now, numerous clients. Although tattooing has been proscribed on several occasions and has suffered waves of unpopularity, it endures and has long held its place among the typically Japanese arts.

In Japan, as in other countries, tattooing originated as an instrument of punishment. The *Nihonshoki*, an eighth-century history, tells of a man who was tattooed as punishment for treason. The result was ostracism, perhaps the most terrible of all punishments in Japan, where more than in most countries family and social ties assume great importance. Consequently, tattooing was reserved for the more serious crimes. The criminal was marked on the forehead or around the eyes, so that proof of his crime would be clearly visible. The method used was to cut the skin and insert pitch, hence the name *irezumi: ire*, "flow into"; *zumi*, "black liquid."

Independent of punishment, another form of tattooing existed in Japan. This was practiced by the Ainu, the aborigines of the northern island of Hokkaido. Their tattoos, perhaps originally magical, were purely decorative. Until recently one could still see Ainu women with blue, moustachelike designs on their upper lips and tattooed whorls on their knuckles. It is possible that the punishment tattoo originated from this form of Ainu decoration, the assumption being that the criminal would be classed with the hated and feared aborigine. Whether or not this is so, tattooing as punishment did not continue for long. Although the practice was revived from time to time, there are no further historical or literary references to tattooing until the 1600s.

A novel of the 1670s, *Shikido Taikyo* ("A History of Amorous Adventures"), describes how prostitutes inscribed the names of faithful customers on their thighs or upper arms. Another book of the period speaks of the subtler device of having the left elbow tattooed with a number of dots signifying the age of the favored customer. The West is familiar with this impulse, and many a white biceps has been decorated with "Mother" or the name of a girlfriend.

In Japan, however, the art of the tattoo did not remain long in this phase. For one reason, tattooing as punishment was revived in the eighteenth century, and the *Gojogaki Hyakkajo* ("One Hundred Articles of the Criminal Code") codified a great number of tattoo patterns, each indicating a separate offense. Perhaps as a consequence the word for tattoo was changed. From *irezumi*, which denotes punishment, it became *horimono*, or "digging the skin," which implies a voluntary decoration; and from abstract patterns, the tattoo developed into an advanced form of decorative art. Despite various proscriptions (in 1811, 1890, and the last in 1908, which was not officially rescinded until 1945), tattooing has flourished in the past two centuries.

Various reasons have been given for the sudden naissance in the 1700s. Tattooing represented one way members of the merchant class could avoid the many edicts against decorating themselves with signs of what we would now call conspicuous consumption. Merchants, in contradistinction to the nobility, were not permitted to wear fine silks, brocades, or gold and silver ornaments. One could, however, wear an expensive tattoo, displaying it only to trusted confidants. So while a rich merchant might wear a plain kimono, vividly embroidered with gold threads on the inside, the merchant's son might sport an equally expensive tattoo on his arm or thigh. It was

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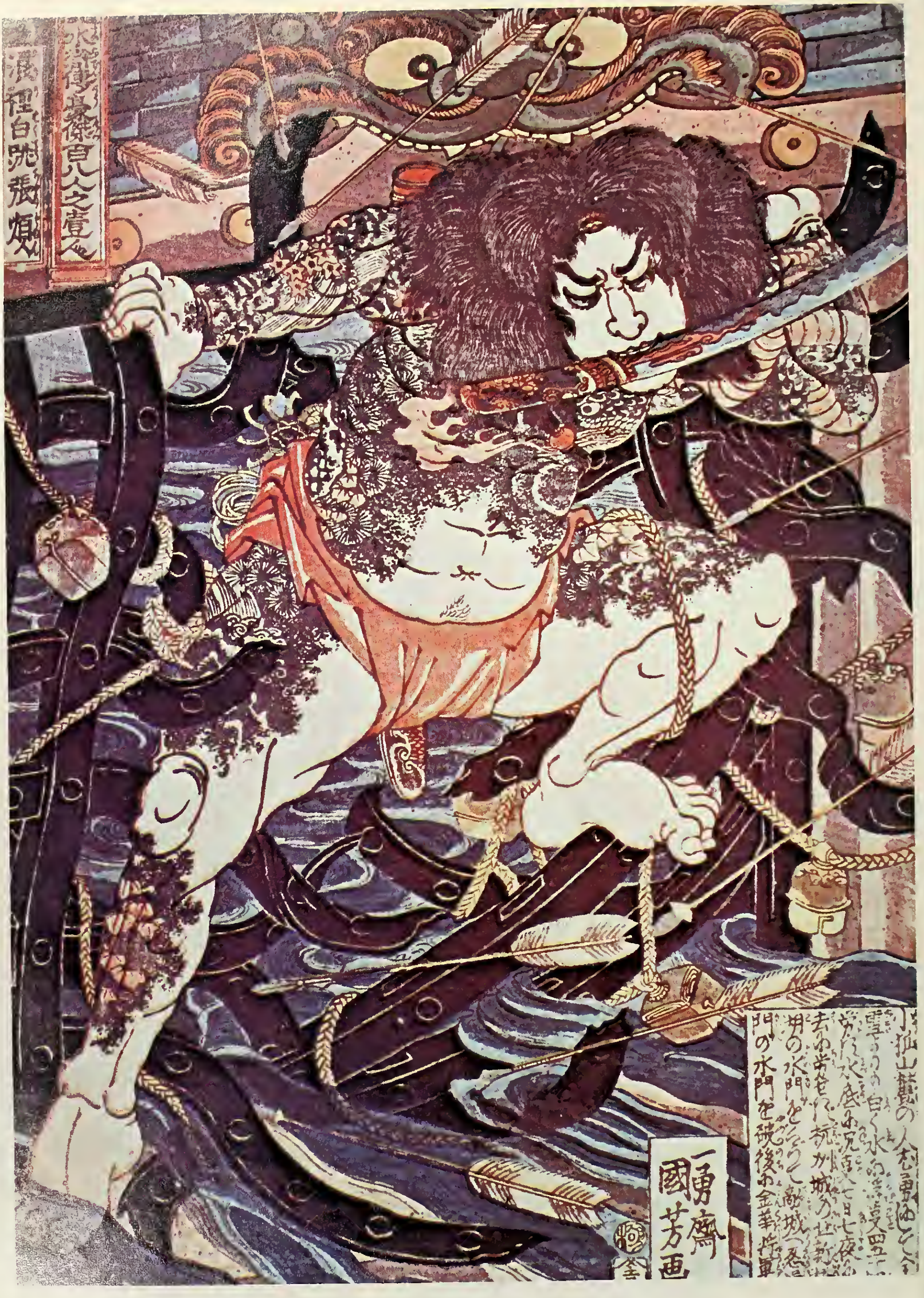
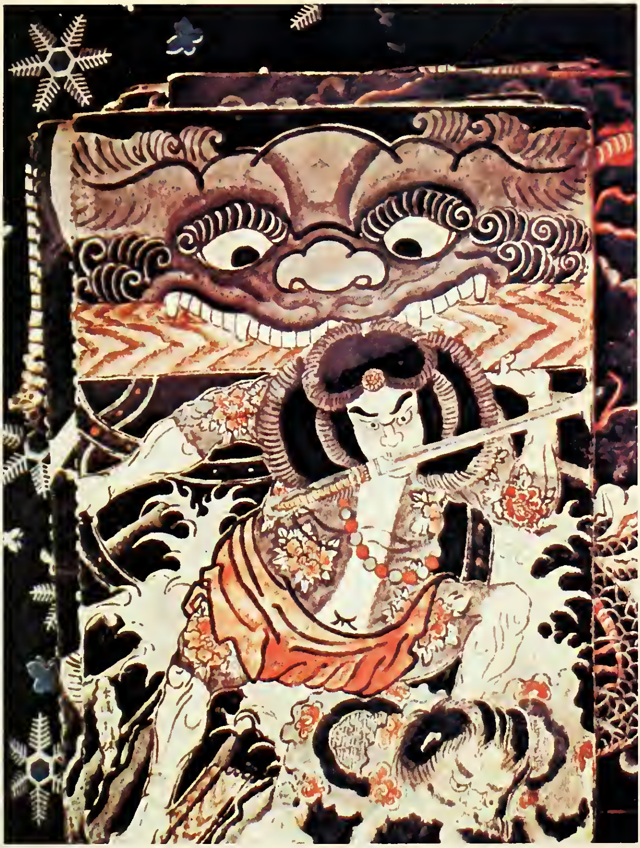
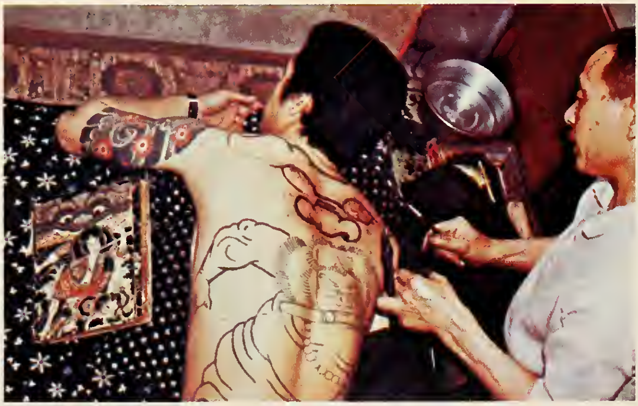
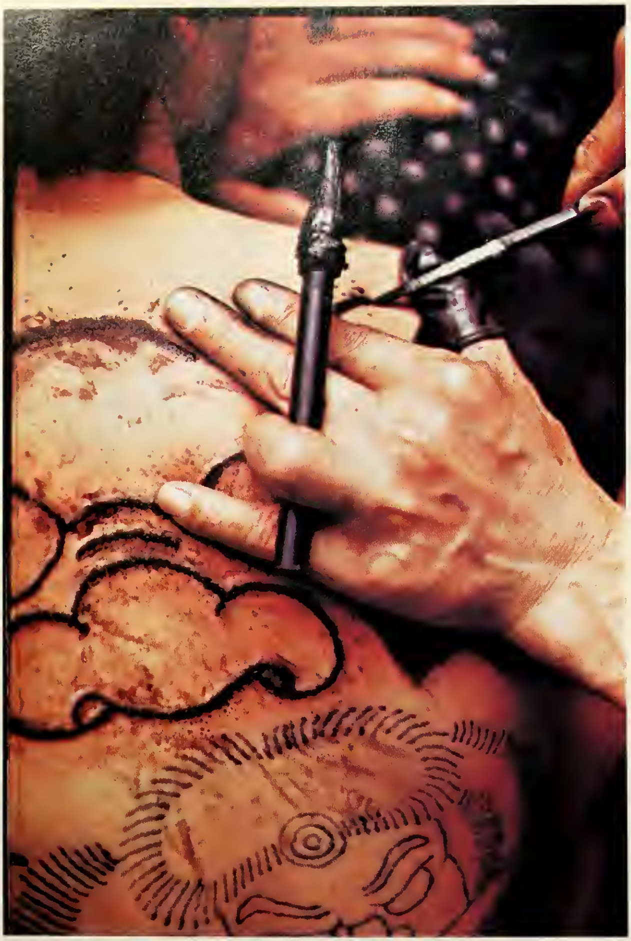
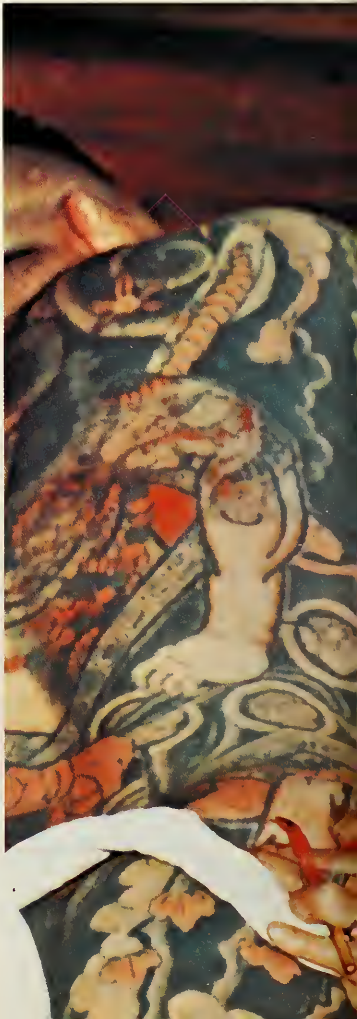

水滸傳豪傑百八人之壹人
浪裡白跳張順
一勇齋國芳画



A nineteenth-century block print, far left, depicts one of the heroes from the "Tales of One Hundred and Eight Strong Men," the source of many tattoo designs. After creating his own wash drawing based on the print, left, and referring to it as he works, a modern-day tattoo master, below, outlines the design on the customer's back.

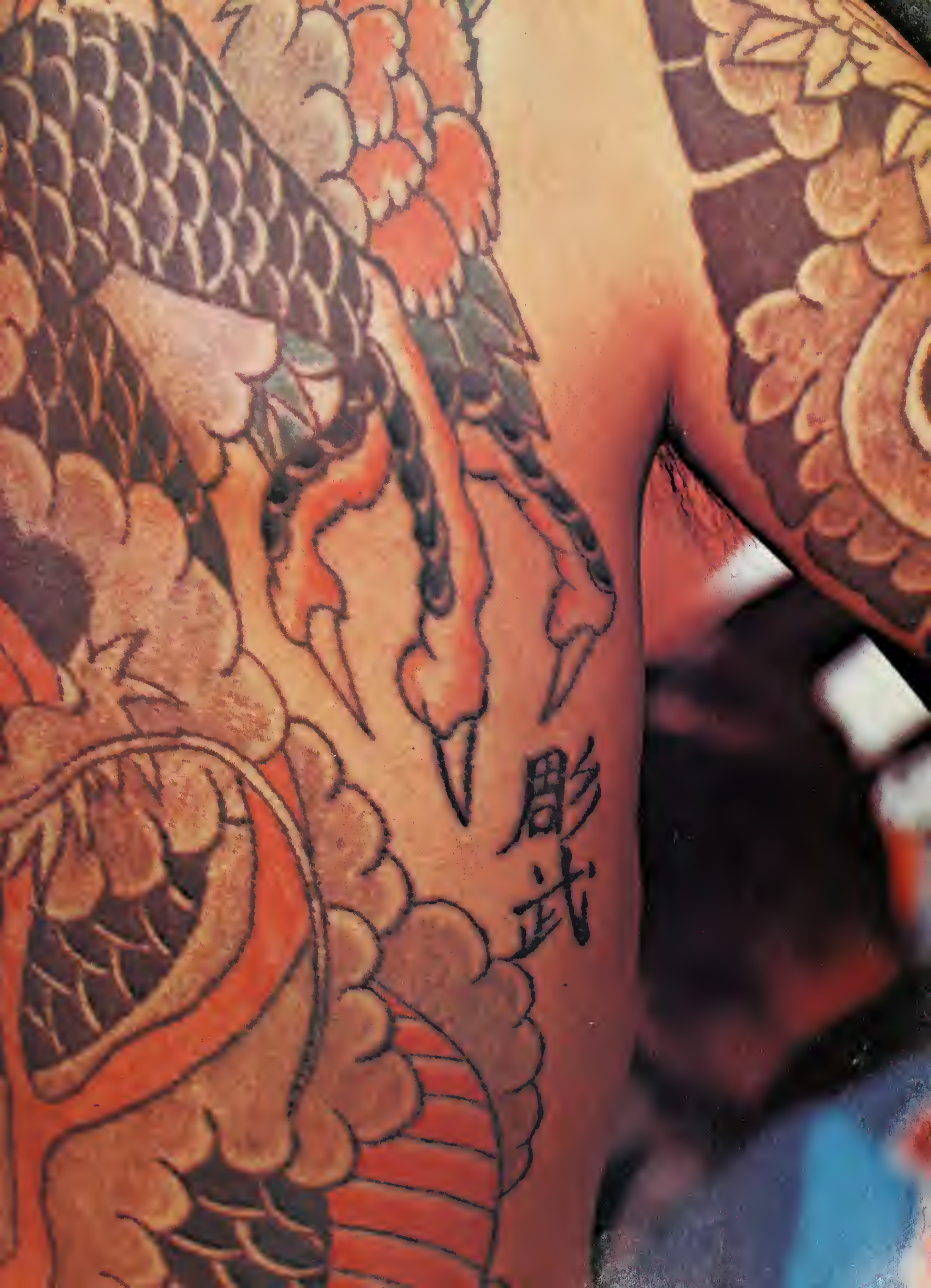






Holding the tattooing tool in his right hand and a dye brush in his left, an artist punctures the flesh and pushes the pigment under the skin. Later the excess pigment will be wiped off, leaving a sharper line. Once the outline is complete, colors are filled in until a full suit is finished. The work is slow and painful, and after each one-hour session, the client soaks in a hot bath to ease the pain and settle the color.

Overleaf: Based on ancient ceremonial robes and traditional designs in Oriental art, tattoos of dragons symbolize strength and sagacity. Like a painter's signature, the name of the tattoo artist, Horitake, appears at lower right, below the dragon's claws.


彫武

Continued from page 50

highly decorative, usually hidden, and definitely antiestablishment.

The tattoo also transcended Japan's rigid class system. The raffish merchant's son and the flashy, low-ranking samurai alike might wear tattoos. So might footmen, fishmongers, gangsters, gamblers, palanquin bearers, firemen, and many professionals. While it may have been an affectation on the part of the merchant's son to adopt the tattoo worn by the proletariat, more important, a tattoo on the wealthy seems to have represented an informal freemasonry. If you wore a tattoo, you were the kind of man who went to the pleasure quarters, who knew his way around town, who was—in contemporary terms—hip.

That a ruling class should be attracted to presumably low-class decoration is not as surprising as it sounds. During Britain's Edwardian period there was a rash of tattooing among European nobility. The Prince of Wales, later George V, and his brother the Duke of Clarence, Duke Alfred of Edinburgh and Coburg, Czar Nicolas II of Russia, Queen Olga of Greece, Prince Phillipe de Caramen Chimay, and the Princesses de Léon and de Sagan all sported tattoos.

One result of the tattoo's popularity in Japan was that the artists were kept busy devising new techniques and styles for customers. During this period, the finished tattooed "suit" was developed. A completely tattooed man wore his decorations from his shoulders to his elbows, halfway down his thighs; his entire back and buttocks were covered; and only a section from his throat through the sternum to the navel, the genitals, and the insides of the thighs was left undecorated. With this suit a footman or a fireman could simply put on a loincloth and be considered well dressed by his peers. There were, and remain, eccentric tattooings—a woman's breasts (the design often being full-blown peonies), the insides of her thighs (usually decorated a delicate peach pink), or the head of a man's penis (the organ lending itself well to decoration as an eggplant, peach, or plum)—but the indicated areas remain the standard tattooing ground of the Japanese.

Such a suit was, and remains, expensive. But it was more than a sign of conspicuous consumption. In eighteenth-century Tokyo, it became a kind of guild mark. The firemen were tattooed, so were the carpenters, so were the gangsters. And even now it is the young woodworker or the young hood who is most likely to go to the tattooer.

To keep up with the demand for increasingly lavish tattoos, the masters experimented and eventually arrived at the style of tattooing now instantly recognized as Japanese. It is based upon the work of several great artists of the period.

At the beginning of the nineteenth century Hokusai brought out his *Shipen Suiko Gaden* ("New Suiko Pictorial Series"), and a decade or so later Kuniyoshi produced another illustrated work, the *Tsuzoku Suikoden Goketsu Hyakuhachinin* ("Popular Suiko Tales of One Hundred and Eight Strong Men"). The text was written by others, and although of the comic strip variety, the illustrations were magnificent and their popularity was extraordinary.

Perhaps to evade censorship these artists, and those who later added to the genre, among them Utamaro, chose to illustrate Chinese-style stories, and their pictures showed strong Chinese influence. Pictures of heroic men battling monsters, engaged in duels, or riding dragons or carp were matched by a number of Japanized folk heroes: Chogoro Konjin, who defeated a number of demons; Harunosuke Aoyage, who could change himself into a snake; and Kohashi Kinezumi, who attained Zen satori while breaking out of a barrel. Also pictured were various animals that had semimagical associations, such as dragons (strength and sagacity) and carp (perseverance). There were also flowers—the cherry blossom and peony were particularly preferred.

The traditional colors for tattooing, which are still widely used in Japan, include *sumi* (a kind of black that turns deep blue under Asian skin), yellow, light blue, occasionally green, and a red made of material so lethal (mainly lead) that the client can tolerate only a few new square inches a week.

The traditional method, still preferred by both masters and clients, is long and painful. A needle is not used. Instead, the artists use a small series of triangular-edged awls or gouges to push the pigment under the skin. First they trace the desired design on the back, arm, or thigh with watered *sumi*. After the outlines are drawn, they are incised with the awls, a lengthy process if the design is at all complicated. The full dye brush, secured by the little finger of the left hand, lies across the top of the knuckles. The gouge, held with the right, is rubbed against the loaded brush, then pushed under the skin. This is repeated until a thick, clear line is achieved. To keep a clean working surface, the master continually sponges the blood away. Finally, the colors are painstakingly worked into the various areas of the design, as one fills in a coloring book.

The amount of design that can be finished in a single working period depends on the strength of the artist and the patience of the customer. Full designs, such as a whole suit, can take up to a year to complete. A full suit, if the artist is well known and a master in this trade, costs thousands of dollars, and those workmen who finally acquire a full tattoo can afford little else.

The finished product is, however, an undisputed and unique work of art. It has a strong and unified style, it exists simply for itself, and its purpose is entirely decorative. For the happy possessor it may also have semimagical associations of good luck or potency. From a feared form of punishment, the tattoo has evolved into one of Japan's most typical decorative arts. □

A full tattoo suit, a rare sight on a Tokyo street, features an elaborate floral design of peonies, cherry blossoms, and chrysanthemums.

Natural and Unnatural Selection in a Wild Goose

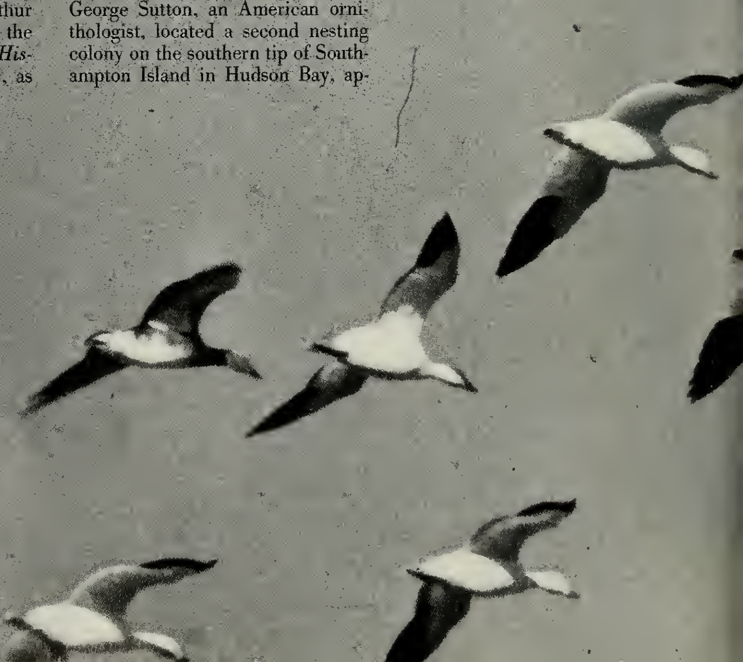
Blue goose and snow goose color phases enable the species to reproduce efficiently in the harsh Canadian climate. But hunters, more eager than sporting, are upsetting this finely tuned pattern of survival

by Paul A. Johnsgard

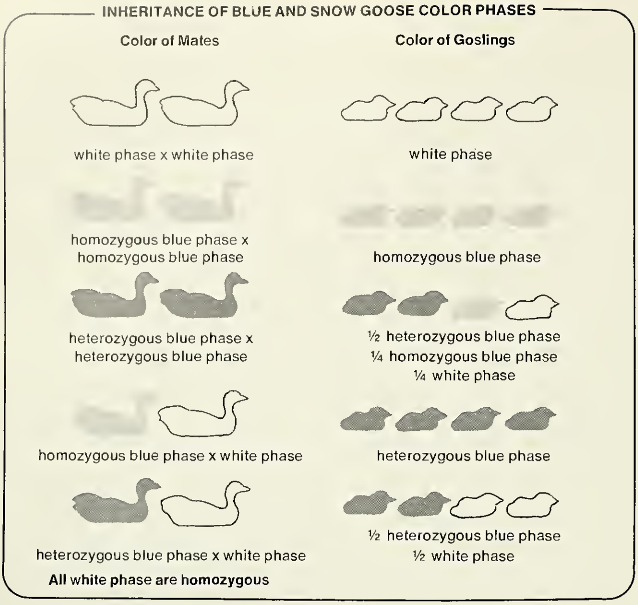
Of all the ecologic, taxonomic, and evolutionary puzzles posed by North American birds, none is more intriguing than that provided by the blue goose and the lesser snow goose.

The blue goose, described in 1758 by Linnaeus on the basis of a drawing of a "blue-winged goose" from the Hudson Bay area and given the name *Anas caerulescens*, had long been a bird of mystery. Each fall enormous flocks would suddenly appear and concentrate in a very small area of coastal Louisiana to spend the winter, then return north and disappear into the wilderness of arctic Canada the following spring. As recently as 1925, Arthur C. Bent was able to summarize the situation in his famous *Life Histories of North American Birds*, as follows: "To find the breeding resorts of the Blue Goose is one of the most alluring of the unsolved problems in American ornithology. It is really surprising that such a large and conspicuous species, which is numerically so abundant, can disappear so completely during the breeding season."

The mystery of the blue goose breeding grounds was solved in 1929 by the Canadian ornithologist J. Dewey Soper. After a seven-year search, which covered about 30,000 miles and extended from Hudson Bay to Greenland, he discovered a major nesting colony on Baffin Island. Only a year later, George Sutton, an American ornithologist, located a second nesting colony on the southern tip of Southampton Island in Hudson Bay, ap-



KENNETH AND BRENDA FORMANEK


INHERITANCE OF BLUE AND SNOW GOOSE COLOR PHASES
Color of Mates
Color of Goslings
white phase x white phase
white phase
homozygous blue phase x homozygous blue phase
homozygous blue phase
heterozygous blue phase x heterozygous blue phase
½ heterozygous blue phase
¼ homozygous blue phase
¼ white phase
homozygous blue phase x white phase
heterozygous blue phase
heterozygous blue phase x white phase
½ heterozygous blue phase
½ white phase
All white phase are homozygous

The color phases of the lesser snow goose are an inherited trait. Homozygous parents—those possessing genes for only one color phase—produce like offspring. Heterozygous parents—possessing genes for both white and blue color phases—account for the appearance of blue and snow geese in the same flock.

Migratory blue and lesser snow geese rest on an Iowa lake. These birds will continue southward to winter on the Louisiana coast.

proximately 400 miles from the Baffin Island colony.

Both Soper and Sutton found lesser snow geese (aptly named *Chen hyperborea hyperborea*, or goose from beyond the north wind), nesting in association with blue geese. The beautiful snow goose, always considered a distinct species, had long been known to nest in the Canadian Arctic, as well as in Greenland and Siberia. Yet on Southampton Island, Sutton found mixed pairs and apparent hybrids between blue and lesser snow geese. This raised the possibility that the two types were not different species but only subspecies or even minor genetic variants. Despite the evidence provided by the mixed pairs and hybrids, Sutton concluded that the lesser snow and blue geese were distinct, although closely related, species. (The greater snow goose does not exhibit color phases.)

A few years later, Canadian ornithologist T. H. Manning visited a different mixed nesting colony on Southampton Island where he found that about half of the blue geese were mated to snow geese. Although this percentage of mixed pairs was below that to be expected if the two types were randomly interbreeding (which would signify that the birds were of the same species), it was far more than would be expected if they represented separate species. As a result, he suggested that the two plumage types should be considered as different subspecies. Although the present-day attitude toward bird subspecies is to regard them as geographically separated and morphologically different populations, Manning's recommendation seemed to be the best solution to an otherwise insolvable problem and was gradually adopted.

A solution to the taxonomic dilemma was not forthcoming until the 1950s, when Graham Cooch, then a graduate student at Cornell University, spent several summers studying the breeding biology of blue and snow geese on Southampton Island. His studies demonstrated that the blue goose is only a genetically determined color phase of the snow goose, and that both birds are, in fact, one species, *Chen caerulescens*. The genetic control determining the two plumage types is a relatively simple one. The factor that prevents massive interbreeding between the two types is a behavioral barrier, the result of preferential pairing between birds of the same plumage type.

Cooch also discovered that blue and snow geese exhibited significant differences in their physiological adaptations for breeding. Although no differences were found in nest-site selection or average clutch sizes, white-phased birds normally began their nesting activities slightly earlier than blue-phased ones. Melting snow and ice at the onset of the white-phased birds' breeding season often results in the loss of some of the nests, which are constructed on slight, grassy swells on the tundra. Also, for reasons not yet understood, egg predation losses to jaegers and arctic foxes tend to be higher during the initial stages of the breeding season. It is possible that, as the snow and ice covering the tundra begins to disappear—shortly after the first eggs are laid in late May or early June, depending on the latitude of the colony site—white-phased birds on the nest are more conspicuous to predators.

By the same token, the blue-phased birds would be better camouflaged on the muddy ground. The two color phases, then, could serve

KENNETH AND BRENDA FORMANEK

as a protective device to keep breeding losses at an acceptable level, while maximizing the limited breeding period (approximately 80 days) possible in severe climates.

In any case, blue-phased pairs are more successful breeders than white-phased pairs, except when an unusually cold and retarded spring reduces the length of the breeding season. This can be especially disadvantageous to the blue goose because it starts breeding later.

Because the blue-phased birds are favored in relatively mild breeding seasons, the past half century of climatic amelioration in arctic Canada has probably benefited the blue goose and has helped account for the extension of the breeding range of birds representing this genotype. The blue goose is now found in nesting colonies north and west of Baffin and Southampton Islands, which previously were entirely comprised of snow geese, and it is becoming relatively more common in breeding areas where both types traditionally occur.

Still largely unexplained was how the geese develop strong preferential mating with birds of their own plumage type rather than showing random mating behavior.

It is possible that the goslings become imprinted on the plumage type of their parents shortly after hatching and later seek out a mate of the same color. If so, goslings whose parents were blue phased would seek blue-phased mates; those with white-phased parents would prefer typical snow geese as mates. Only in cases where the young birds are the offspring of mixed parents might a gosling be imprinted on a color phase opposite from its own. Fred Cooke, a Canadian geneticist, hypothesized that in such a case the young bird did imprint on the plumage type of one of its parents, perhaps depending on the gosling's sex. The only certain way to test this idea was to band thousands of goslings in a colony that had a substantial proportional representation of both color phases. One such colony is near Churchill, Manitoba, and in 1968 Cooke and his associates began a long-term study to try to resolve this question.

One problem associated with such a study is the goose's long period of immaturity. Among arctic geese, initial breeding normally occurs when the birds are nearly three years old. Thus, it takes at least that long from the time of initial banding to determine the mating preferences of goslings having parents of known color phases.

Nevertheless, some suggestive evidence has already begun to emerge from this research program. By raising captive goslings of the two color phases—as well as white-phased goslings dyed pink—with foster parents that were either blue, white, or pink dyed, it was possible to test the young birds' social responses when they were later placed together in a large flock. When the goslings were tested in a circular arena and allowed to move toward adults of any of the three color types, they associated predominantly with adult birds of the same color as their foster parents. Even the goslings with pink foster parents responded as strongly to them as did those with normally colored parents, suggesting that color recognition is learned rather than inherited. There was no evidence to suggest that the sex of a gosling had any effect on its behavior or that the sex of the foster parent had any effect.

The banding program undertaken by Cooke and his associates has also brought to light a number of interesting points in addition to the behavioral basis for preferential mating. First, a considerable degree of mixing of both blue and snow geese from different breeding colonies apparently exists on the Gulf Coast wintering grounds, where pair formation occurs. This allows for the formation of pair bonds between birds reared in different breeding colonies. As a result, a male from one colony may form a pair bond with a female that was reared at another colony several hundred miles away. Cooke has concluded that, as is the case with ducks, it is the female rather than the male that determines to which colony the pair will return and attempt to nest. Such behavior tends to promote outbreeding between colonies and thus would also encourage genetic uniformity between

On its breeding grounds near Churchill, Manitoba, a snow goose watches the flight of a bird of prey.

JEN AND DES BARTLETT, BRUCE COLEMAN, INC.

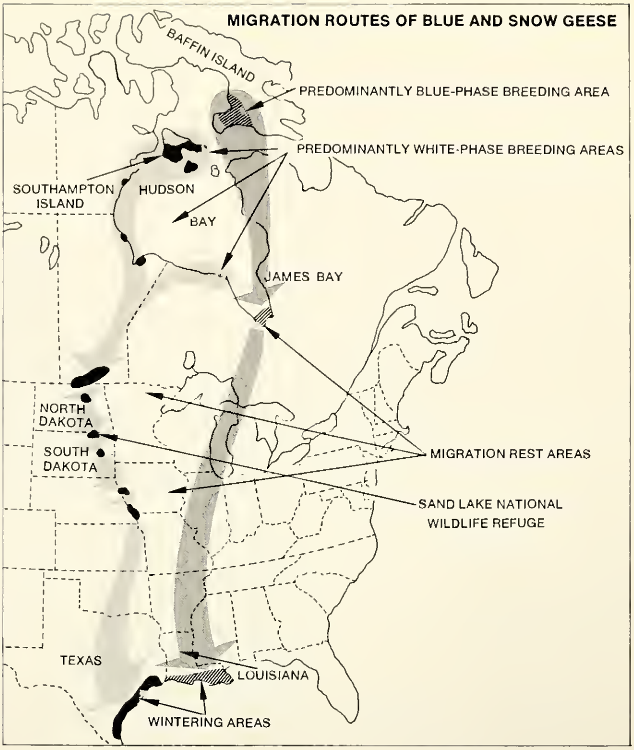
J. VAN WORMER, BRUCE COLEMAN, INC.

breeding populations separated by several hundred miles.

The different breeding colonies in arctic Canada—those that are predominantly blue geese, snow geese, or mixed in various proportions—all have different migration patterns when they head southward in the fall, and this also has important genetic implications, as well as ecological significance. In recent years, it has even had political ramifications. The predominantly blue-phased geese that breed on Baffin Island, for example, typically undertake a nearly nonstop flight to their Louisiana wintering grounds. The geese spend several weeks in early September in a staging area at James Bay, Canada, where the birds are subjected to fairly heavy hunting pressure, but their subsequent nonstop flight carries them out of reach of waterfowl hunters in the northern United States. It is only while the geese are passing the winter in Louisiana that hunters take a heavy toll of their number.

On the other hand, the geese, predominantly white-phased, which breed on Southampton Island and the west coast of Hudson Bay, follow a more gradual and interrupted fall migration pattern. They also spend weeks along the south coast of Hudson Bay, but from there they strike out in a southwesterly direction across Ontario and southern Manitoba toward the Dakotas. There, in the vicinity of Devils Lake, North Dakota, and Sand Lake, South Dakota, the birds rest and take on food before they continue their flight southward. In years when the breeding season is later than usual, this stopover in the northern states is especially important, since the young of the year are unable to withstand a more direct flight to the wintering area on the coast of Texas. In such years the immature birds are especially vulnerable to hunting because of their generally weaker condition, and up to a third of the young geese may fall to hunters.

The genetic and ecologic implications of these differences in migratory traditions are thus substantial. Whereas the mostly blue-phased breeding population avoids heavy hunting pressure in the northern United States by its relatively nonstop migration between James Bay and the Gulf Coast of Louisiana, the predominantly white-phased populations of Southampton Island and the west coast of Hudson Bay are subjected to the effects of intensive hunting throughout their entire fall migratory route down the Great Plains to their Texas wintering areas. In addition, most sport hunters shoot the white-plumaged birds rather than the darker blue geese, probably because they are more conspicuous and may have greater trophy appeal. Thus


MIGRATION ROUTES OF BLUE AND SNOW GEESE
BAFFIN ISLAND
PREDOMINANTLY BLUE-PHASE BREEDING AREA
PREDOMINANTLY WHITE-PHASE BREEDING AREAS
SOUTHAMPTON ISLAND
HUDSON BAY
JAMES BAY
NORTH DAKOTA
SOUTH DAKOTA
MIGRATION REST AREAS
SAND LAKE NATIONAL WILDLIFE REFUGE
TEXAS
LOUISIANA
WINTERING AREAS

White-phased geese that breed on Southampton Island and the west coast of Hudson Bay follow an interrupted migration pattern down the Great Plains to wintering areas on the Texas coast.

The predominantly blue goose breeding colonies follow a more direct, uninterrupted migration route than colonies made up largely of snow geese or mixed populations.

the differential effects of hunting on the two plumage types supplement the differential breeding adaptations, and may influence the rate of natural selection in favoring blue-phased birds.

In the fall of 1972, an extraordinarily cold arctic summer resulted in very low breeding success for nearly all arctic-breeding birds. Another factor that reduced the goose population was the high kill rate in North Dakota, the third highest in history. Of the approximately 95,000 geese killed in that state alone, some 53 percent were white-phased snow geese and 20 percent were blue-phased birds (27 percent were other species).

After the abysmal 1972 breeding season and the heavy hunting of the fall, the winter mid-continent population of snow geese was estimated at slightly more than a million birds, or down nearly 23 percent from the previous winter.

Obviously, the prospect of such continued goose hunting as occurred in the Dakotas in 1972 will have enormous local economic impact, and state game agencies in the northern states have been eager to manage their temporary goose populations in a way that will assure the highest possible harvests for their hunters.

Their solution has been to encourage a buildup of massive fall goose populations in a few refuge areas where the birds can safely rest. To obtain food, however, the birds must fly out beyond the refuge boundaries. The resulting concentrations of geese—and hunters—that have occurred at Sand Lake National Wildlife Refuge and numerous other midwestern refuges have imposed a crass carnival atmosphere on goose hunting in the area. Now, rather than bothering with blinds, decoys, goose calls, and all the other accoutrements of goose hunting, it is only necessary to stand at the boundaries of the refuge, carry a magnum shotgun loaded with buckshot, and fire randomly at any flock of birds that comes within eyesight. (The better hunters, who kill the greatest number of birds annually, still use decoys and other lures. These sportsmen show a preference for snow over blue geese.) Although the total number of geese killed in this incredible "sport" is relatively low compared with the total taken from all states during the season, the incidence of crippled birds, which die later or fall well within the refuge boundaries and thus cannot be recovered, is substantial.

Hunters in the wintering areas of Louisiana and Texas have not remained impassive in the face of increasing harvests of snow and blue geese in the northern states. Recently, both federal and state game agencies have been accused of "shortstopping" the birds in order to increase the harvests in more northerly states. This is the term applied to the management of refuges or other controlled areas along the fall migratory route by providing food or planting grain to encourage maximum fall usage by geese and to delay their departure to wintering areas for as long as possible. This procedure had its predictable outcome last winter, when a large flock of geese and ducks that were concentrated on Lake Andes National Wildlife Refuge in southern South Dakota were affected by a severe outbreak of viral enteritis, or "duck plague," which killed thousands of waterfowl. The affected geese were Canada geese rather than snow geese, but the potential for a disaster of comparable or even greater magnitude certainly exists with the latter species.

In the resultant controversy, the least of the participants' concerns appears to be the welfare of the goose population, which has been gradually losing ground in recent years. Unless adequate protection can be offered the birds on their fall migration routes—as well as in their wintering areas—the problem of shortstopping may eventually become only an academic question.

Furthermore, the major nesting areas, such as those on Southampton and Baffin Islands must be absolutely protected from destruction or disturbance. Increased interest in oil and mineral exploration in the Canadian Arctic will make this a problem of greater concern in future years. The effect of the forthcoming James Bay Hydroelectric Project on the fall staging area of the geese still remains to be seen, but it could have an important influence on the migration routes and timing of the Hudson Bay goose flocks.

A goose population is a dynamic system that responds rapidly and intensely to subtle and manifold environmental pressures. The genetic "marker" provided by the blue-phased plumage variant allows a revealing insight into the workings of natural selection in a harsh and intolerant environment. For better or

Hunters in the northern Plains states take a high toll of migrating geese every fall. Their preference for white-phased birds is influencing the population balance between blue and lesser snow geese.

worse, man is influencing the rate at which natural selection is shifting the genetic composition of the Hudson Bay goose flock and modifying the migratory traditions of the birds as well.

Each spring the geese push relentlessly northward to rendezvous with fate on distant arctic shorelines; each fall they return with the future of their species invested in a new generation of offspring produced by the most successful genetic combinations. We could ask for no greater symbol of innate determination for survival than that provided by the snow and blue geese; accordingly, we should be content with no less than a maximum commitment to their continued existence. ☐

Giant Pandas in the Wild . . .

Zoologists, reporting back from the rugged mountains of southwest China, offer new understanding of these captivating animals

by Wang Sung and Lu Chang-kun

When Hsing Hsing and Ling Ling, two giant pandas from the People's Republic of China, arrived at the National Zoological Park in Washington in 1972, thousands of people flocked to see the first giant pandas exhibited in an American zoo since 1953.

Traditionally, zoos offer the public a chance to view foreign or rare animals, but in addition they provide research opportunities for biologists and other scientists. The Peking Zoo acquired its first giant panda in 1956, and other large Chinese zoos got them soon after. From observation and research of these captive pandas, Chinese zookeepers and zoologists have accumulated much valuable experience concerning the animal's care and feeding, as well as data on its growth and propagation. In September, 1963, the birth of Ming Ming, at the Peking Zoo, marked the first time a giant panda had been born in captivity. Since then several other giant pandas have been born in Chinese zoos. These events provide information not easily obtained in natural surroundings about the development of the individual panda; they also offer a new basis for the study of the evolution of the giant panda as a species.

To understand the behavior of the giant panda, however, it is necessary to go into the high mountains and observe the animal in the wild. Researchers from Chinese institutes and universities, working with local people and experienced hunters, have done much investigation of the animal in its natural habitat.

The giant panda (*Ailuropoda melanoleuca*) is found only in the mountains of southwest China. Now rare, it once ranged over a wide area. Paleontological research shows that during the Middle and Late Pleistocene, about 600,000 years ago, the giant panda was distributed throughout the southern part of China. Its fossils have been discovered in Szechuan, Yunnan, and Fukien provinces, and in the Kwangsi Chuang Autonomous Region. Similar fossils have also been found in Burma. The fossil evidence indicates that the climate of the period was much warmer than at present. Many animals, including the orangutan, hyena, tapir, and stegodon, adapted to such a warm climate, were unable to survive the subsequent Ice Age and became extinct in China. Only the giant panda survived.

Today giant pandas are found in northern and central Szechuan and in the mountains fringing the southernmost part of Kansu province. In 1964 giant pandas were also discovered just inside the southern border of Shensi province.

The giant panda inhabits mixed conifer and broadleaf forests in high mountain ravines 9,000 to 13,000 feet above sea level. The climate is generally damp with cool summers and very cold winters. Rain, snow, and hail are frequent. The China-cane bamboo (*Sinarundinaria*) forests in the area are so dense that one cannot see more than a yard ahead. These provide a natural refuge and inexhaustible food reserve for the giant panda.

It was once thought that this mammal was a vegetarian, eating only bamboo. Investigators, however, have now found animal bones in the stomach of a panda that had died, indicating that while bamboo is its main food, it is also sometimes carnivorous.

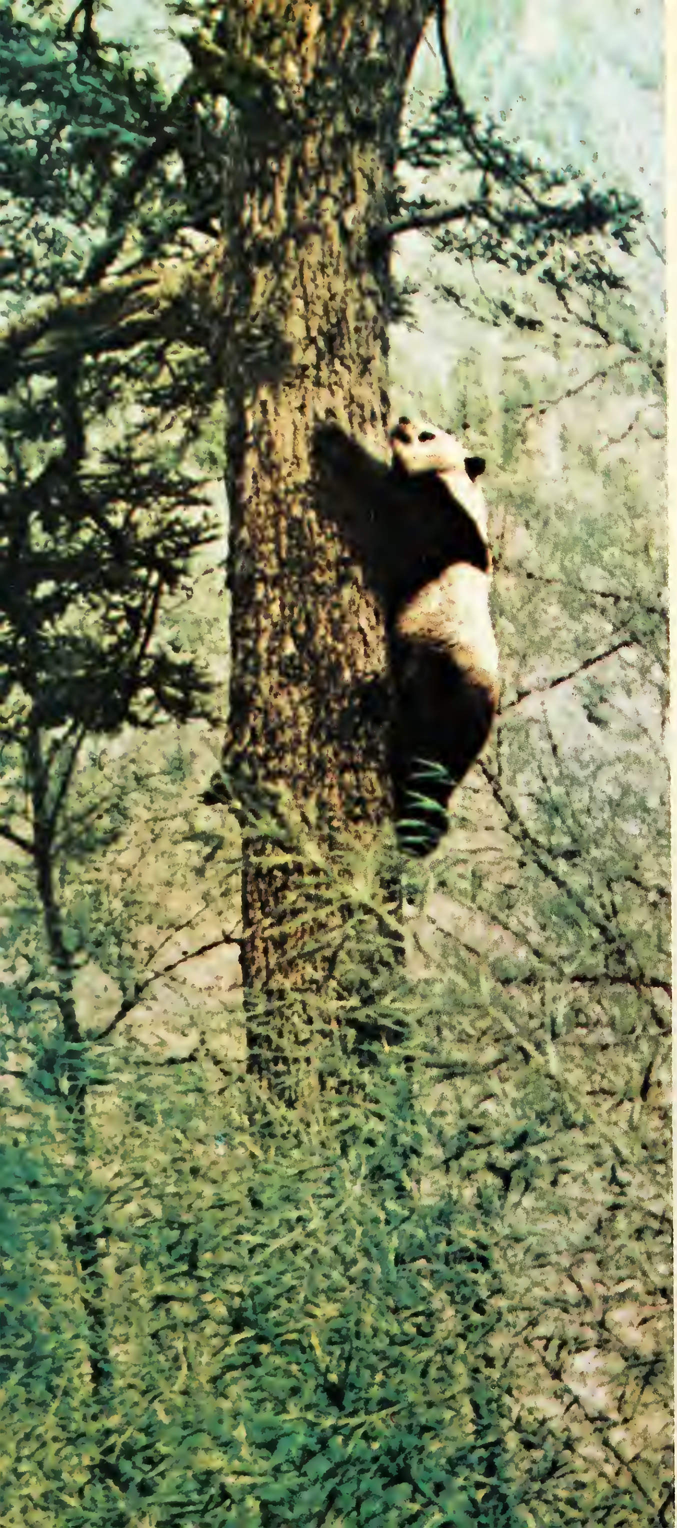
Despite the severity of the winters, giant pandas do not hibernate, but instead, go down into the lower ravines, returning to the higher mountain slopes in summer. Ordinarily, giant pandas have no permanent dens, and the males and females live apart.

During the mating season in late spring and early summer, one can hear the animal's low, deep mating call sounding through the quiet mountain forests. When the female is about to give birth in the autumn of the same year, she will settle in a hollow tree or cave, bear her cub, and nurse it. A newborn giant panda, weighing only about three or four ounces, is no larger than an adult white rat. It is thinly covered with white fur and cannot crawl until it is three months old.

By adulthood a giant panda weighs more than 200 pounds. Its body varies from five to six feet in length, but its tail is less than eight inches long. The fur on its body is white, with black on the limbs and in a strip across the shoulders. The two small black ears and an oval black patch surrounding each eye give the white furry face a wistful, clownlike expression.

The giant panda usually lumbers along at a leisurely pace. Sometimes an investigator can even come within 60 feet of it. But if it senses danger, it will dart back along its own trail or, showing surprising speed and agility, climb a big tree. Because the panda can also swim across mountain streams, its natural enemies, the red dog and leopard, pose no serious threat.

The giant panda's existence, however, has been threatened by human activities. In old China many kinds of rare birds and mammals were caught or indiscriminately slaughtered, bringing some species to the verge of extinction. After the establishment of the new China in 1949, the Communist party and people's government



adopted a wildlife policy that included preservation, breeding in captivity, and controlled hunting. The giant panda heads the list of rare animals that must be preserved, and hunting it is prohibited. Permission must be obtained from the wildlife authorities before a panda can be captured, even for research or for a zoo.

The areas inhabited by the giant panda have been turned into nature reserves. One of these, the Wanglang Nature Reserve in Szechuan province, covers an area of nearly 80 square miles in the rugged terrain and dense forests of the Min Shan Mountains. Other famous rare animals, such as the takin and golden monkey, also inhabit the reserve. Once on the verge of extinction, these animals have been increasing in number since the policy of preservation was instituted.

There is still a great deal to be learned about the giant panda. Some research, such as the study of the panda's physical, anatomical, and serological features, takes place in the laboratory. Studies of its distribution and the distribution of its fossils, however, require extensive field work. Finally, we are all captivated by the playful and congenial giant panda in the zoo, but to understand how it has adapted and how it functions in its rugged habitat, we have to encounter it in its home in southwestern China.

Showing great agility,
a giant panda climbs a fir
tree in the Wanglang Nature
Reserve, a large, protected
area in Szechuan province.

CHINA PICTORIAL

. . . and in a Biochemical Laboratory

Molecular analysis of blood proteins reveals the giant panda's family ties

by Vincent Sarich

The question of the giant panda's ancestry has long been a vexing one. Unlike children, to whom the "panda bear" is a favorite toy and who have no difficulty identifying the animal's origins, scientists have been perplexed since the animal was discovered in 1869. Generally, biologists agree that the giant panda's closest affinities are with bears (ursids) or raccoons (procyonids), but then the controversy starts. The usual possibilities considered are: (1) the giant panda's closest relative is the lesser panda, a species usually classified among the raccoons; therefore, the giant panda should also be in the raccoon family; (2) the pandas belong in a separate family altogether; (3) the giant panda is an aberrant bear, and therefore belongs among the ursids.

If the bear ancestry idea is correct and we assume that bears and raccoons diverged from a common ancestor, with the giant panda line subsequently splitting off from bears, then the giant panda and the bear should today retain some characteristics that developed after the raccoon line split off and before the giant panda–bear divergence. The problem, of course, is to find such characters—that is, those that retain within their modern structures a discernible objective record of past evolutionary changes.

Proteins are nearly ideal characters of this sort. A protein is a linear sequence of amino acids joined in head-to-tail fashion and folded upon itself to form a functioning unit. When we look at functionally equivalent proteins from different species, however, we find that their amino acid sequences can differ from one another. In general, the more distant the evolutionary relationship between the two animals, the greater the number of positions at which different amino acids

will be found in the sequences.

To start with, I obtained blood samples from Chi-Chi, a giant panda that died in Regents Park Zoo, London, in 1972. To place her in proper evolutionary perspective, immunological techniques were used to compare two of her blood proteins—albumin and transferrin—to those of bears, raccoons, and the lesser panda. The antibodies used were prepared in rabbits by injecting them with the albumins and transferrins of the black bear and the raccoon; they were then reacted with each of the albumins and transferrins involved.

Although it sometimes eats meat, the giant panda's main food is bamboo, which grows abundantly in the animal's damp mountain habitat.

CHINA PICTORIAL

Antibodies, of course, react best with the protein most similar in amino acid sequence to that against which they were originally prepared; they react less well when proteins of greater sequence difference are used. The differences in reactivity are expressed as immunological distances (IDs), where one ID unit corresponds approximately to one amino acid substitution. An ID of 50, for example, would indicate that the protein of the two species being compared carries different amino acids at about 50 positions in the sequence.

Using these antibodies, we obtained the following ID values among the pandas, bears, and raccoons:

With antibodies to *Ursus* molecules

	ID Units
Polar bear	15
Giant panda	22
Lesser panda	74
Raccoon	85

With antibodies to *Procyon* molecules

	ID Units
Kinkajou	51
Black bear	85
Giant panda	87
Lesser panda	100

While these figures clearly demonstrate that the giant panda's blood proteins are much more similar to those of the black bear than to those of the raccoon, we had one further problem. How did we know that this similarity was due to a recent common ancestry and not to the fact that neither set of molecules had changed very much over a long period of time? By reacting antibodies to the albumins and transferrins of species in other carnivore families (dog, mink, seal, sea lion, and walrus) with the albumins and transferrins of the various bear, panda, and raccoon species, we obtained the following mean ID values: black bear, 122 units; giant panda, 122 units; lesser panda, 128 units; and raccoon, 125 units. Thus, not only have the proteins of all these animals been changing but they all show similar amounts of change since they last shared a common ancestor.

Obviously then, the albumin and transferrin of the giant panda are those of a bear; indeed, at the molecular level, the giant panda–bear similarity is as marked as that of a dog and fox, cat and lion, or baboon and rhesus monkey.

On the other hand, the lesser panda belongs neither with the raccoon family Procyonidae nor with the giant panda; our current tentative placement makes it a very early offshoot of the ursid lineage, one that broke off before typical bear characteristics developed.

These conclusions echo those of other biologists, including Dwight Davis, who after a detailed dissection of a giant panda, stated:

> Every morphological feature examined indicates that the giant panda is nothing more than a highly specialized bear. . . . *Ailurus* [lesser panda] obviously has nothing to do with *Ailuropoda* [giant panda] or the Ursidae. . . . I am not sure that *Ailurus* belongs with the Procyonidae, which is where all modern authors place it.

Why then has the controversy persisted? I suspect that its longevity may be due partly to its curiosity value—to the undoubted appeal of what could be termed the "Look how Mother Nature is fooling us" argument. □

A New Weapon Stirs Up Old Ghosts

by William E. Mitchell

Were the Wape hunters just poor shots
or did vengeful spirits really make them miss their quarry?

When, in 1947, the Franciscan friars went to live among the nearly 10,000 Wape people of New Guinea, the principal native weapons were bone daggers and the bow and arrow. Even then, game was scarce in the heavily populated mountains where the Wape live, and the killing of a wild pig or a cassowary, New Guinea's major game animals, was an important village event. The Wape live in the western part of the Sepik River Basin. Their small villages lie along the narrow ridges of the Torricelli Mountains, above the sago palm swamps where women process palm pith, the Wape staff of life.

Today the Wape hunter's principal weapon is still the bow and arrow and game is even scarcer. This is partially the result of a new addition to the hunter's armory—the prosaic shotgun—which has had a profound moral impact on Wape village life.

The first guns were brought into this area in the late 1940s and early 1950s by missionaries, traders, and Australian government officials. Although natives were not permitted to own guns, they could use them if employed by a white man to shoot game for his table. This was a very prestigious job.

Mani, *represented by a high conical mask, is a spirit who can insure good hunting. As he prances about the village, his joyful mien amuses the children.*

In 1960, government regulations were changed to permit natives to purchase single-shot shotguns. At first only a few Wape men, living in villages close to the government station and helpful to government officials, were granted gun permits. Eventually more permits were issued, but today, in hopes of preserving the remaining game, one permit is issued for every 100 people.

Within ten years of the granting of the first gun permits, a belief and behavioral system had evolved around the shotgun. It was based on traditional Wape hunting lore but had distinctive elaborations stemming from native perceptions of the teachings of government officials and missionaries. For descriptive purposes I call this system of formalized beliefs and ritual the "Wape shotgun cult." It is one of several Wape ceremonial cults, but the only one originating after contact with Europeans. Although the specific practices of the shotgun cult vary from village to village, the underlying beliefs are the same.

In creating the shotgun cult the Wape faced the challenge of adapting an introduced implement to their culture. Unlike steel axes and knives, which replaced stone adzes and bamboo knives, the shotgun has never replaced the bow and arrow. The shotgun is a scarce and expensive machine. This, together with the European sanctions imposed upon its introduction, places it in a unique position, both symbolically and behaviorally, among the Wape.

The cult is a conservative institution. It breaks no new cognitive ground by challenging established Wape concepts. Instead it merges traditional hunting concepts with European moral teachings to create a coherent system. The cult upholds traditional beliefs, accepts European authority, and most important, provides an explanation for unsuccessful hunting.

In 1970, my family and I arrived in Lumi, a small mountain settlement, which is the government's subdistrict headquarters in the middle of Wapeland. For the next year and a half, we lived in the village of Taute, near Lumi. There my wife and I studied Wape culture.

Taute, which has a population of 220, is reached by narrow foot trails, root strewn and muddy, passing through the dense, damp forest. The low houses—made of sago palm stems and roofed with sago thatch—are scattered about in the sandy plaza and among the coconut palms and breadfruit trees along the ridge. Towering poinsettias, red and pink hibiscus, and multicolored shrubs contrast with the encircling forest's greens and browns. A few small latrines perch on the steep slopes, concessions to Western concepts of hygiene. In the morning, flocks of screeching cockatoos glide below the ridge through the rising mists. When the breadfruit trees are bearing, giant fruit bats flop across the sky at dusk.

Since the mid-1950s the Franciscan friars have maintained, off and on, a religious school in Taute.

LIAM E. MITCHELL

There, Wape boys are instructed by a native catechist in Catholicism, simple arithmetic, and Melanesian Pidgin. A priest from Lumi visits the village several times a year, and the villagers, Catholic and heathen alike, are proud of their affiliation with the Franciscans and staunchly loyal to them. But their Catholicism is nominal and superficial—a scant and brittle frosting that does not mask their own religious beliefs, which dominate everyday life.

The ethos of Wape society is oriented around sacred curing rituals. Whereas some Sepik cultures aggressively center their ceremonial life around headhunting and the raising of sturdy and brave children, the Wape defensively center theirs in the ritual appeasement of malevolent ghosts and forest demons, who they believe cause sickness. Most men belong to one of the demon-curing cults where, once initiated as priests, they are responsible for producing the often elaborate curing ceremonies for exorcising the demon from the afflicted.

The little money that exists among the Wape is earned primarily by the men, who work as two-year contract laborers on the coastal and island copra plantations. Because of the lack of money to buy canned meats, the scarcity of game, and the paucity of fish in the mountain streams, the protein intake of the Wape is exceedingly low. The most common meal is sago dumplings and boiled leaves. Malnutrition is common among youngsters, and physical development is generally retarded. According to studies by Dr. Lyn Wark, a medical missionary who has worked widely among the Wape, the average birth weight of the Wape baby is the lowest recorded in the world. Correspondingly, secondary sex characteristics are delayed. For example, the mean age for the onset of menses is over eighteen years.

Before contact with Westerners, Wape men were naked and the women wore short string skirts. Today most men wear shorts and the women wear skirts purchased from Lumi's four small stores. To appear in a semblance of European dress, however meager or worn, is a matter of pride and modesty to both sexes. "Savages" do not wear clothes, but white men and those who have been enlightened by white men do. In this sense, the Wape's Western-style dress represents an identification with the politically and materially powerful white man. The identification is with power; it is an ego-enhancing maneuver that permits the Wape to live with dignity, even though they are subservient to Western rule and influence. The tendency of the Wape to identify with, and incorporate, the alien when it serves to preserve their culture will help us to understand how they have woven diverse cultural strands into the creation of the shotgun cult.

From the first day I arrived in Taute, the men repeatedly made two urgent requests of me. One was to open a store in the village, saving them the difficult walk into Lumi; the other was to buy a shotgun to help them kill game. This was the least, they seemed to indicate, a fair-minded and, in Wape terms, obviously rich neighbor should do. One of the hardest things the anthropologist in the field must learn is to say "no" to deserving people.

To be stingy is almost to be un-American, but we had come halfway around the world to learn about the Wape way of life, not to introduce stores and shotguns that would alter the established trading and hunting patterns.

After several months the people of the major Taute hamlets, Kafiere, where we lived, and Mifu, a ten-minute walk away, each decided to buy a group-owned shotgun. The investment was a sizable forty-two Australian dollars; forty dollars for the gun and two dollars for the gun permit. Each hamlet made a volunteer collection from its members and I, as a fellow villager, contributed to both guns. A week later the villagers purchased the guns from one of the Lumi stores, and I began to learn about the shotgun's ritual and moral importance to the Wape. The villagers were already familiar with the significance of the shotgun for they had purchased one several years before. The cult ended, however, when the gun broke.

Left, men carry a wild pig into a hunting camp. There it will be ritually butchered and distributed to other villagers by the owner of the cartridge, which the gunman, below, used to kill the animal.

The shotgun, like Melanesian Pidgin, is associated by the Wape with Europeans and modernity. Not surprisingly, Pidgin is favored for shotgun parlance. The licensed gunman is not only called *sutboi* ("shootboy") but also *laman* ("law man"), the latter a term that connotes his official tie to European law and government as perceived by the villagers.

When a candidate for a gun permit appears before the government official in Lumi, he is examined orally on the use of firearms, then given an unloaded shotgun and tested on his handling knowledge. Under the direct and questioning gaze of the examining official, candidates sometimes become flustered. One inadvertently aimed the gun first toward the wife of the assistant district commissioner and then toward a group of observers. His examination ended ignominiously on the spot.

If the candidate passes the test and the examining official approves of his character, he is then lectured on the use of the gun: only the candidate can fire it, he must willingly shoot game for his fellow villagers, and the gun must be used exclusively for hunting. He is strongly warned that if any of these rules are broken or if there is trouble in the village, he will lose the gun and the permit and will be imprisoned.

The candidate's friends and the inevitable audience are present for the lecture. Here, as in many spheres of native life, the official's power is absolute, and the Wape know this from long experience.

Guns have been confiscated or destroyed without reimbursement, and gunmen have been jailed.

The official's charge to the candidate is willingly accepted. Henceforth, he will never leave the village without carrying his gun. He is now a *laman*, and he has the gun and permit, printed entirely in English, to prove it.

The government official's strong sanctions against village quarrels are motivated by his fear that the gun might be used in a dispute among villagers. The sanctions are further upheld by the missionaries' and catechists' sermons against quarreling and wrongdoing as they attempt to teach the Christian doctrine of brotherly love. The message the villagers receive is this: To keep the white man's gun, they must follow the white man's rules. This the Wape do, not in servile submission, but with some pride because the presence of the gun and the public focus on morality mark the village as progressive and modern. The licensed gunman, therefore, is not only the guardian of the gun but of village morality as well.

Rain or shine, he is expected to go into the forest without compensation to hunt for his fellow villagers, who give him cartridges with some personal identifying mark upon them. After a gunman makes a kill, the owner of the cartridge receives the game and distributes it according to his economic obligations to others. But the gunman, like the bow and arrow hunter, is forbidden to eat from the kill; to do so would jeopardize further successful hunting.

In the hamlet of Kafiere, the clan that had contributed the most money toward the gun and on whose lands the most game was to be found appointed Auwe as gunman. But Auwe's wife, Naiasu, was initially against his selection. Her previous husband, Semer, now dead several years, had been Kafiere's first *sutboi* and she argued that the heavy hunting responsibilities of a *sutboi* took too much time, forcing him to neglect his own gardening and hunting obligations.

When Auwe first requested a gun permit he was turned away. The villagers believed that the ghost of Naiasu's dead husband, Semer, had followed Auwe to Lumi and influenced the examining official against him. Semer's ghost was acting to fulfill Naiasu's wish that her young son, now Auwe's stepson, would have a stepfather who was always available. This was the first of many stories I was to hear about the relationship between ghosts and the gun. When Auwe returned to Lumi for a second try, he passed the examination and was given the official permit.

The hamlet now had its own gun and hunting could begin in earnest. The first step was an annunciation feast called, in Pidgin, a *kapti* ("cup of tea"). Its purpose was to inform the villagers' dead ancestors about the new gun. This was important because ancestral ghosts roam the forest land of their lineage, protecting it from intruders and driving game to their hunting descendants. The hunter's most important hunting aide is his dead male relatives, to whom he prays for game upon entering his hunting lands. The dead remain active in the affairs of the living by protecting them from harm, providing them with meat, and punishing those who have wronged them.

The small sacrificial feast was held in front of Auwe's house. Placing the upright gun on a makeshift table in the midst of the food, Auwe

WILLIAM E. MITCHELL

Indeed, there are no general community-wide feasts. The *kapti* is apparently modeled on a European social gathering.

For the remainder of my stay in Taute, I followed closely the fortunes of the Taute guns and of guns in nearby villages as well. All seemed to be faced with the same two problems: game was rarely seen; and when seen, was rarely killed. Considering that a cartridge belongs to a villager, not the gunman, how was this economic loss handled? This presented a most intriguing and novel problem for there were no analogs to this type of predicament within the traditional culture. By Wape standards, the pecuniary implications of such a loss, although but a few Australian shillings, could not graciously be ignored by the loser. At the very least the loss had to be explained even if the money for the cartridges could not be retrieved.

Now I understood the concern about the ancestral ghosts. If the hunter shot and missed, the owner of the fired shells was being punished by being denied meat. Either he or a close family member had quarreled or wronged another person whose ghost-relative was securing revenge by causing the hunter to miss. This, then, was the functional meaning of the proscription against quarreling. By avoiding disputes, the villagers were trying to prevent the intervention of ancestral ghosts in human affairs. In a peaceful village without quarrels, the gunman could hunt undisturbed by vengeful ghosts chasing away game or misrouting costly shells.

Although a number of factors in European culture have influenced the shotgun cult, the cult's basic premise of a positive correlation between quarreling and bad hunting is derived directly from traditional Wape culture. In bow and arrow hunting, an individual who feels he was not given his fair share of a hunter's kill may punish the hunter by gossiping about him or quarreling openly with him. The aggrieved person's ancestral ghosts revenge the slight by chasing the game away from the offending hunter or misdirecting his arrows. But this is a private affair between the hunter

At a feast held to appease ghosts who might have been causing game to flee, the upright shotgun, above, is placed near the offerings. The food, left, consisting of sago dumplings and boiled tulip leaves, is later consumed by the villagers.

rubbed it with sacred ginger. One of Auwe's elderly clansmen, standing and facing his land, called out to his ancestors by name and told them about the new gun. He implored them to send wild pigs and cassowaries to Auwe.

Several men spoke of the new morality that was to accompany hunting with a gun. The villagers should not argue or quarrel among themselves; problems must be settled quietly and without bitterness; malicious gossip and stealing were forbidden. If these rules were not obeyed, Auwe would not find game.

In traditional Wape culture there is no feast analogous to the *kapti.*

and the angered person; their quarrel has no influence upon the hunting of others. And it is rare for an issue other than distribution of game to cause a ghost to hinder a bowman's success. The hunter's prowess is restored only when the angered person performs a brief supplication rite over the hunter.

This, then, is the conceptual basis for the tie between quarreling and bad hunting. Originally relevant only to bow and arrow hunting, it was then broadened to accommodate the government's pronouncements about the shotgun and keeping the village peace. And it applies perfectly to the special circumstances of shotgun hunting. Because the shotgun is community owned and many villagers buy cartridges for it, the villagers are identified with both the gun and the gunman. As a proxy hunter for the villagers, the gunman is potentially subject to the ghostly sanctions resulting from their collective wrongs. Thus gun hunting, unlike bow and arrow hunting, is a community affair and the community-wide taboo against quarrels and personal transgressions is the only effective way to prevent spiteful ghosts from wrecking the hunt.

No village, however, even if populated by people as disciplined and well behaved as the Wape, can constantly live in the state of pious peace considered necessary for continuous good gun hunting. When the hunting is poor, the gunman must discover the quarrels and wrongs within the village. After having identified the individuals whose ancestral ghosts are sabotaging the hunting, the gunman must also see to it that they implore the ghosts to stop. Embarrassed by the public disclosure, they will quickly comply.

The common method for detecting points of friction within the village is to bring the villagers together for a special meeting. The gunman will then document in detail his misfortunes and call on the villagers to find out what is ruining the hunting. If confessions of wrongdoing are not forthcoming, questioning accusations result. The meeting, beginning in Pidgin, moves into Wape as the discussion becomes more complex and voluble. It may last up to three hours; but even if there is no resolution, it

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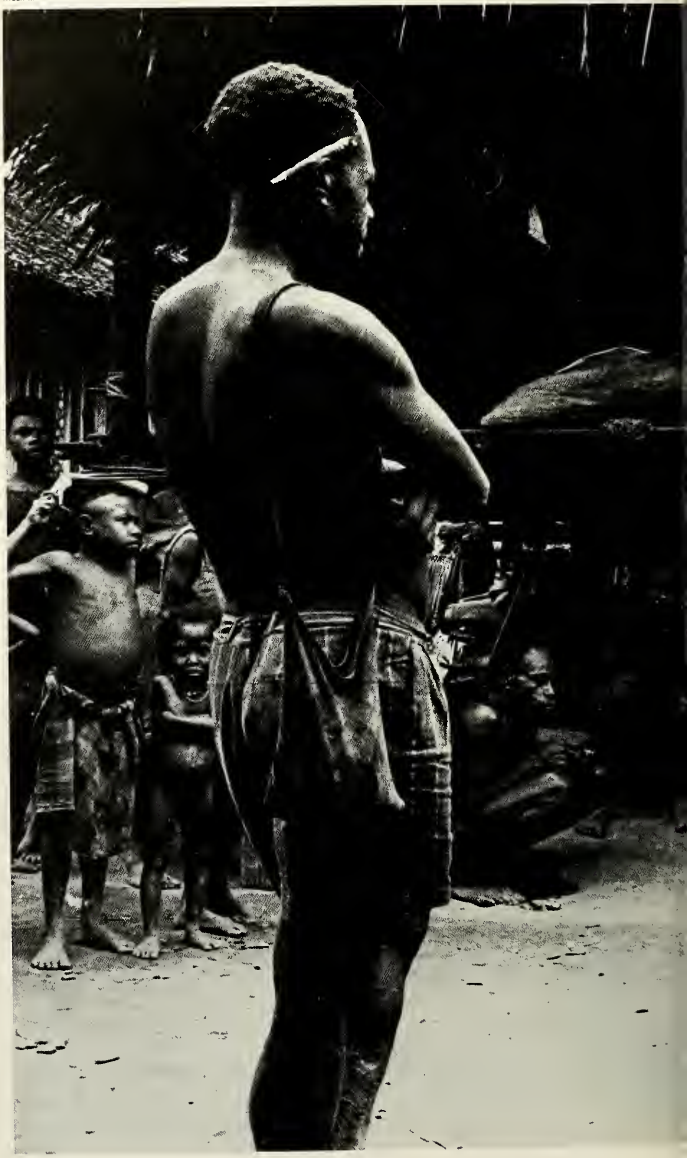

At a "shotgun clinic," a clairvoyant questions a woman. If she bears any grudges against other villagers, her ancestors might be avenging her by preventing the gunman from killing game.

always ends amiably—at least on the surface. For it is important to create no new antagonisms.

The other technique for locating the source of the hunting problem is to call in a professional clairvoyant. As the villagers must pay for his services, he is usually consulted only after a series of unsuccessful meetings. Clairvoyants have replaced the shamans, who were outlawed by the government and the mission because they practiced sorcery and ritual murders. The Wape do not consider a clairvoyant a sorcerer; he is a man with second sight who is experienced in discovering and treating the hidden causes of intractable problems. As such, shotguns are among his best patients.

Mewau, a clairvoyant from a neighboring village, held a "shotgun clinic" in Taute to examine the Mifu and Kafiere guns. For about

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an hour he examined the two guns and questioned the villagers. Then he declared the reasons for their misfortune.

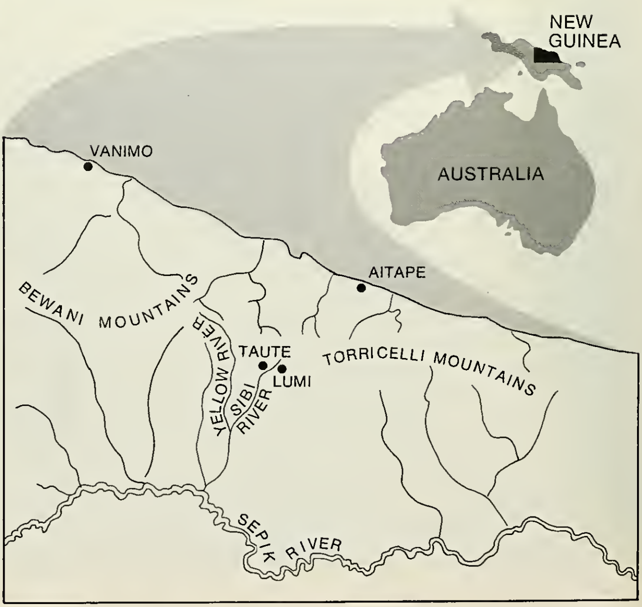
Kapul, a dead Mifu shaman, was preventing the Mifu gun from killing game because a close relative of the gunman had allegedly stolen valuables from Kapul's daughter. Because of the family ties between the gunman and the thief, Kapul's ghost was punishing the gunman.

The Kafiere gun, Mewau declared, was not able to find game because a widow in the village felt that her dead husband's clan had not previously distributed game to her in a fair way. By interfering with the Kafiere gun, her husband's ghost was punishing his clan for the neglect of his family.

Once the source of trouble is named, there are several possible types of remedial ritual depending upon the seriousness of the situation. For example, the circumstances surrounding the naming of the husband's ghost were considered serious, and a *kapti* was held to placate him. Another, simpler ritual involves the preparation of taro soup, which the gunman consumes. But the simplest, commonest remedial rite is the supplication ritual without sacrificial food offerings, a ritual in which I became involved.

Mifu's gunman had shot a pig with one of his own cartridges but did not give me the small portion due me as a part owner of the gun. Partly as a test to see if my ancestors counted for anything in Taute and partly because I did not want to let this calculated slight go unchallenged, I, in typical Wape fashion, said nothing to the gunman but gossiped discreetly about his selfishness. The gunman continued to hunt but had no further success. When his bad luck persisted, a meeting was called to find out the reason. The gunman asked me if I was angry because I had not been given my portion of the pig. When I acknowledged my anger, he handed the shotgun to me and I dutifully spoke out to my ancestors to stop turning the game away from the gun.

But the gunman still had no success in the hunt, and the villagers decided there were other wrongs as well. The search for the offending ghosts continued. Eventually the villagers became so discouraged with the Mifu gun that they stopped giving cartridges to the gunman. The consensus was that a major undetected wrong existed in the hamlet, and until it was uncovered and the guilty ghost called off, hunting with the gun was senseless and extravagant. Thus the propriety of a



remedial rite is established if there is success on the next hunt. The system is completely empirical; if no game is seen or if seen, is not killed, then the search for the wrong must continue.

Wape people are generally even tempered, and their villages, in contrast to many in New Guinea, strike the newcomer as almost serene. But the social impact of the guns at this time was pervasive, and life in Taute literally revolved around the guns and their hunting fortunes. Whereas the villagers previously had kept to their own affairs, they now became embroiled in meeting after meeting, seeking out transgressions, quarrels, and wrongdoing. As the gunman continued to have bad luck. his efforts to discover the cause became more zealous. A certain amount of polarization resulted: the gunman accused the villagers, the men accused the women, and the adults accused the young people of hiding their wrongs. And a few who had lost many cartridges wondered if the *sutboi* was keeping the game for himself. But no one ever suggested that he was an inexperienced shotgun hunter. The gunman was generally considered to be blameless; in fact. the more game he missed, the more self-righteous he became and the more miscreant the villagers.

Six months of poor hunting had gone by; the villagers felt that the only recourse left to them was to bring a bush demon named *mani* into the village from the jungle for a festival. The *mani*'s small stone heart is kept enshrined in a rustic altar in a corner of Kafiere's ceremonial house and after a kill the animal's blood is smeared upon it. The *mani* will reward the village with further kills only if he is fed with blood. *Mani* is the only spirit, other than ghosts, who can cause both good and bad hunting depending upon the way he is treated. Soon after the shotgun arrived in Taute, the gunman and some other men left their homes to sleep in the men's ceremonial house to keep *mani*'s stone heart warm. They thought *mani*, in appreciation, would send game to the gunman.

When little game was killed, the villagers decided on the hunting festival. In a special house outside of the village, men constructed the great conical mask that depicts *mani*. For several weeks they

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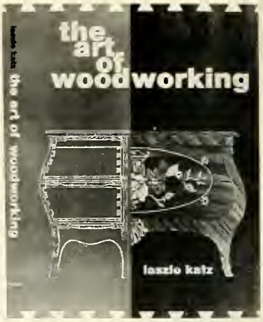
worked to cover the mask's frame with the spathes of sago palm fronds painted with designs traditional to *mani*. Finally, a priest of the *mani* cult, wearing a 20-foot-high mask festooned with feathers and leaves, pranced into the village to the thunderous beat of wooden drums.

For the next week and a half men from other villages who wished us well came and joined in the all-night singing of the *mani* song cycle. In the morning, if the weather was clear, *mani* led the bow and arrow hunters and the gunman to the edge of the village and sent them on their way to hunting success. But in spite of the careful attentions the villagers directed toward *mani*, he rewarded them with only one wild pig. The villagers became openly discouraged, then annoyed. Finally the hunters, disgusted and weary from numerous long futile hunts, and other men, their shoulders sore and bloody from constantly carrying the heavy mask around the plaza, decided that *mani* was simply taking advantage of them; all of their hard work was for nothing. Disgusted, they decided to send *mani* back to his home in the forest.

One late afternoon the *mani* appeared in the plaza but he did not prance. He walked slowly around the plaza, stopping at each house to throw ashes over himself with his single bark cloth arm. The villagers said he was in mourning because he had to leave by dusk and would miss the company of men. Silently the people watched the once gay and graceful *mani* lumber out of the village. The men and boys followed him into the forest. Then the gunman split open the mask, to insure the spirit's exit and eventual return to his forest home, and hurled it over the edge of the cliff into the bush below.

A few months after the *mani* hunting festival, the shotgun cult as I had known it in Taute ceased to function. All but one of the able young men of the hamlet of Kafiere went off to work on a coastal plantation for two years. With no young men, the ceremonial activities of the hunting and curing cults were suspended and the fault-finding meetings halted until their return. The drama and excitement of the previous months had vanished with the men. ☐



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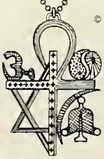

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Botanist Charles Darwin

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Had Charles Darwin never contributed to the theory of organic evolution, he would still have gone down in history as a remarkably gifted and intuitive experimental botanist. Many plant physiological investigations of today are based on leads that he uncovered. Entire areas, such as studies of hormonally controlled correlations, can be said to have developed directly from his simple experiments and the observations he made.

Born in 1809, Darwin was the grandson of Erasmus Darwin, a well-known zoologist and botanist, and a cousin of Sir Francis Galton, the anthropologist who also contributed so fruitfully to biostatistics and eugenics. Nothing about his early life foreshadowed his noteworthy future. He was a wealthy, rather indolent, and physically weak young man whose early educational ventures were disasters. Of the Shrewsbury School, where he studied under Samuel Butler, he says in his autobiography, "The school as a means of education to me was simply a blank." He did not know what to do with himself after graduation and reports his father as exclaiming in mortification, "You care for nothing but shooting, dogs, and rat-catching, and you will be a disgrace to yourself and all your family." Were such a young man to apply to one of today's better universities, he would undoubtedly be denied admission.

In 1825, at the age of 16, his father sent him to Edinburgh University, where Darwin's brother was studying medicine, with the intention that Charles also enter medical training. As with many parental plans for children, this one didn't take. Charles himself explains, "I became convinced from various small circumstances that my father would leave me property enough to subsist on with some comfort, though I never imagined that I should be so rich a man as I am; but my belief was sufficient to check any strenuous effort to learn medicine."

University courses in zoology and geology repelled him. He says of them, "The sole effect they produced on me was the determination never as long as I lived to read a book on geology, or in any way to study the science."

Nevertheless, it was at Edinburgh that Darwin's interest in natural science was aroused. While attending the university he took part in the activities of the Plinian Society, which met to read papers on the subject.

In 1826, Darwin transferred to Cambridge University to study theology, again with disastrous results. "During the three years I spent at Cambridge my time was wasted, as far as the academical studies were concerned, as completely as at Edinburgh and at school," he writes in his autobiography. "I attempted mathematics, and even went during the summer of 1828 with a private tutor (a very dull man) to Barmouth, but I got on very slowly." Fortunately, at Cambridge Darwin became acquainted with a professor of botany, J. S. Henslow, whom he accompanied on botanical walks. Darwin ultimately became a friend of the Henslow family, frequently sharing dinners and scientific conversation with their guests. It was through Henslow's friend Captain Fitz-Roy that Darwin was invited to join the crew of the *Beagle* as the official naturalist. The cruise of the *Beagle* changed his entire life, laying the foundation for all his subsequent scientific interests.

From 1839, when he published his research from the *Beagle*, to 1859, when the *Origin of Species* appeared, Darwin's main concern was evolutionary theory. Geologic, zoological, and botanical data were of course interwoven in the base from which the theory arose. His first mainly botanical publication was *The Various Contrivances by Which Orchids are Fertilized by Insects*, published in 1862. The data for this work had been collected for more than twenty years, as the autobiography recounts.

> During the summer of 1839 I was led to attend to the cross-fertilization of flowers by the aid of insects, from having come to the conclusion in my speculations on the origin of species, that crossing played an important part in keeping specific forms constant. I attended to the subject more or less during every subsequent summer.

This work led Darwin to a study of dimorphic flowers in primroses (*Primula*) and other species. The significance of dimorphism in plants is that it protects against self-pollination and thus permits greater variation in evolution.

> I do not think anything in my scientific life has given me so much satisfaction as making out the meaning of the structure of these plants [*Primula*]. I had noticed in 1838 or 1839 the dimorphism of *Linum flavum* [flax], and had at first thought that it was merely a case of unmeaning variability. But on examining the common species of *Primula* I found that the two forms were much too regular and constant to be thus viewed. I therefore became almost convinced that the common cowslip and primrose were on the high-

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road to become dioecious;—that the short pistils in the one form, and the short stamens in the other form were tending towards abortion. The plants were therefore subjected under this point of view to trial; but as soon as the flowers with short pistils were fertilized with pollen from the short stamens, they were found to yield more seeds than any other of the four possible unions, and the abortion-theory was knocked on the head. After some additional experiments, it became evident that the two forms, though both were perfect hermaphrodites, bore almost the same relation to one another as do the two sexes of an ordinary animal. With *Lythrum* [loosestrife] we have the still more wonderful case of three forms standing in a similar relation to one another. I afterwards found that the offspring from the union of two plants belonging to the same forms presented a close and curious analogy with hybrids from the union of two distinct species.

Some of Darwin's other investigations may yet be the precursors of new pathways in experimental botany. About 1860, he became interested in insectivorous plants, especially the sundew (*Drosera*), whose sticky tentacles move to surround and digest any insect that chances to land on them. Darwin found that sundews can digest meat and other proteins by means of excreted enzymes. As a result of feeding experiments, he found that it was not only proteins that caused the plant's reactions but that simple salts were also effective. He listed all the salts he tested according to their activity, and discussed the effects of acids, alkaloids, and many other groups of substances. Each of his experiments was carried out with the proper controls, and in cases where no response was obtained he often treated the leaves with ammonium carbonate to ascertain whether they were still sensitive or not to any stimulus. Even a statistician would be satisfied with Darwin's experiments since in all his work he used many thousands of leaves.

In 1858, he read a short paper on tendril movements in wild cucumber plants written by Asa Gray, the famous American botanist. The

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Political Storm Signals Over the Sea

by Patrick A. Mulloy

The wealth of the oceans is in dispute.
If open conflict between the divergent interests of the developed and
developing nations is to be avoided,
new rules acceptable to all must be adopted

The fundamental doctrine of the law of the sea is freedom of the seas. This principle was established in the early 1600s when the concept of *Mare Liberum* ("free sea"), promulgated by the Dutch scholar Hugo Grotius, prevailed over the dogma of *Mare Clausum* ("closed sea"), proposed by the English scholar John Selden. The essence of the doctrine is that no state has a right to establish national sovereignty over the high seas three miles beyond its coast, and that all states have equal rights to use the high seas subject to reasonable regard to such use by other states.

Freedom of the seas served the interests of the few powerful maritime states that mattered during the age of exploration and later served well the need to avoid interference with growing international commerce. The doctrine has been the cornerstone for the development of the law of the sea, and international law in general, for the last three and a half centuries.

Today, we are faced with the most severe crisis in the law of the sea since its establishment as a rule of law among nations. A growing number of developing coastal nations now assert claims to 200-mile territorial seas. If their claims were accepted and adopted by coastal states on a worldwide basis, more than 30 percent—some say up to 50 percent—of the world's oceans would come under the jurisdiction of one or another national state. In such a case, international commerce, fishing, scientific research, and security patterns would be thoroughly disrupted and the danger of international conflicts greatly increased. The developing nations have made their claims, not because they wish to cause such disruptions, but rather because the present system of three-mile territorial seas no longer serves their needs. Because of the mounting conflict over an acceptable definition of territorial seas, the international community of nations, through the United Nations, is attempting to create a consensus for a new law of the sea that will accommodate each nation's particular interests. A conference with that aim is scheduled to begin substantive work in April, 1974, in Santiago, Chile.

The first significant break with the traditional law of the sea was the unilateral claim to a twelve-mile exclusive fisheries zone put forth in 1911 by Czarist Russia. After coming to power in 1917, the Soviet government converted that claim into an assertion of a twelve-mile territorial sea. A fisheries zone, as the term suggests, gives a state exclusive rights to fisheries only within the prescribed area. A territorial sea, on the other hand, confers on a state exclusive jurisdiction over all uses of the waters, including air rights over it and passage below the surface. Within its territorial sea a state can ban subsurface passage of vessels and overflights by airplanes of other nations. While most nations permit merchant marine vessels to pass under the vague conditions of "innocent passage," some hold that surface military vessels do not have that right. And some states also hold that the right of merchant ships to innocent passage depends on the cargo carried or the flag flown by the vessel.

In the 1920s and 30s, following the action taken by the USSR, other nations interested in assuring exclusive access to their coastal fisheries made similar claims to broadened territorial seas. A dispute developed between advocates of a three-mile and those of a twelve-mile territorial sea limit, and all attempts in this century to resolve the matter have been frustrated. Both camps have agreed, however, that the doctrine of freedom of the seas applies beyond twelve miles. But the precedent for unilateral claims was set by the Soviet move. After World War II, when the development of fishing techniques, the exploitation of the seabed, and environmental problems conflicted with the traditional three-mile territorial zone, unilateral rather than multilateral solutions became the order of the day.

Technology advanced quickly during and after the war. Because of their need for petroleum, industrialized nations developed methods to find and recover petroleum at increasingly greater depths on the seabed, even at depths beyond their territorial seas. It had also been known for many years that so-called manganese nodules, a generic term for small mineral lumps containing copper, nickel, manganese, and cobalt, covered large areas of the deep ocean floor beneath the high seas. Since exploitation of those resources was impossible with the then available technology, it did not matter that there was no legal authority to govern their development.

Prior to World War II most nations did not object if fishermen from other countries fished off their coasts as long as they stayed outside whatever exclusive fishing zone was claimed, whether three or twelve miles. But the postwar development—particularly by the USSR and Japan—of highly mechanized factory fleets, using sophisticated sonar equipment to locate fish, changed the views of many nations. The huge new fleets often depleted stocks of fish on which nationals of the coastal states depended for their own nutritional or economic well-being. This depletion caused many developing nations to wonder if the traditional freedom of fishing on the high seas really served their individual interests.

Respected scientists from many countries also began to call attention to the threat to marine life posed by increasing amounts of toxic wastes being dumped into the oceans by the industrialized nations. A number of oil spills from tanker accidents awakened many governments to the hazard posed by the mounting number and size of oil tankers. To allow such abuses to continue in the name of freedom of the seas became foolhardy in the eyes of many.

Postwar technological advances were coupled with the political development of many newly emergent coastal nations. Possessing no wide-ranging shipping, naval, or fishing fleets, these nations had little interest in the distant seas beyond their own coasts. They began to question whether the traditional law of the sea, which allowed the developed nations to fish off their coasts and claim the oceans' mineral resources, served their national interests.

It was not an emerging nation, however, but the United States that became the first country to modify the law of the sea in the face of the new technological developments. To safeguard petroleum deposits on its continental shelf the United States, in the Truman Proclamation of 1945, unilaterally asserted "a special interest" in the resources of its own continental shelf, extending well beyond twelve miles, and proclaimed its exclusive right to exploit such resources. The proclamation did indicate that the U.S. claim was not meant to interfere with the traditional freedom of the sea in waters above the shelf. Other industrialized nations soon made similar claims to the resources on their own continental shelves.

Offshore petroleum and natural gas deposits are usually found on continental shelves. In 1952, three Latin American countries—Chile, Ecuador, and Peru—having no continental shelves and thus being without significant petroleum resources off their coasts, claimed a "special interest in their rich coastal fisheries." To safeguard those fisheries, which include the richest tuna and anchovy grounds in the world, the countries claimed jurisdiction over the waters and seabed to a distance of 200 miles from their coasts, citing the Truman Proclamation as a precedent for their actions. Other nations soon followed suit, and the long list of countries, developing and developed, now making claims for extended jurisdiction to protect their fisheries includes Iceland, Nigeria, Senegal, Sierra Leone, Mexico, Argentina, and Brazil.

In the past ten years, at least 200 U.S. tuna boats have been seized off Ecuador and Peru, and U.S. shrimp boats have been taken by Brazil with a resultant straining of our relations with these countries. Similarly, Iceland and the United Kingdom have been having a "cod war" because of continued British fishing within a 50-mile zone claimed by Iceland. Such problems are symptomatic of other struggles to come if an accommodation of interests is not made.

Two previous United Nations Conferences on the Law of the Sea have also contributed to the present crisis. A monumental effort was made at the 1958 Geneva conference to codify the then existing law of the sea. Eighty-four nations attended, including forty-six developing countries of Asia, Africa, and Latin America. The conference adopted a number of conventions, among them one giving coastal states jurisdiction on their continental shelves to a depth of 200 meters, or about 650 feet, but it failed to achieve an agreement on the maximum breadth for the territorial sea or the breadth of a zone in which coastal states might have exclusive fisheries jurisdiction. An impasse developed between the maritime states, which possess merchant marines or distant-water fishing fleets and have an interest in international trade, and the coastal-fishing states, whose interests lie primarily in the exploitation of the fisheries located in their own offshore waters.

In 1960, the international community tried again to resolve the disputed issues. The United States and Canada, which are both maritime and coastal-fishing states, attempted to break the impasse between the opposing groups by jointly proposing a territorial sea to a maximum of six miles and an exclusive fishing zone of another six nautical miles beyond the territorial sea. The proposal failed by a single vote to obtain the necessary two-thirds majority required by the conference rules for incorporation into a treaty.

Soon after this second failure, a majority of coastal states extended their territorial seas to twelve miles, mainly to protect their fisheries. In 1966 the United States, responding to complaints from its coastal fishermen over abuses of their fisheries by distant-water fleets, primarily those of the USSR and Japan, unilaterally declared a twelve-mile fishing zone while clinging tenaciously to its three-mile territorial sea claim. Even now the United States Congress is considering legislation to unilaterally extend the U.S. exclusive fishing zone out to 200 miles. Advisers in the executive branch, fearing the results such a move would have on the country's bargaining power at the pending Law of the Sea Conference, have sought to postpone such legislation.

In retrospect, it can be seen that the 1958 Geneva conference failed to anticipate the problems arising from the march of technology, especially those connected with exploitation of minerals on the deep-sea floor. The continental shelf convention agreed on at that time gave coastal states resource jurisdiction to a depth of 200 meters. The convention also extended jurisdiction "beyond that limit [200 meters] to where the depth of the superadjacent water admits of the exploitation of the natural resources of the said area." Since few diplomats at the 1958 conference seriously thought that seabed resources below the 200-meter depth would soon be recoverable, they compromised on this ambiguous phrase in order to obtain agreement on a convention. The phrase is interpreted by some proponents of expanded coastal state jurisdiction over seabed resources as bestowing jurisdiction all the way to the middle of the ocean. As sea mining technology improved in the 1960s, it became clear that the question of who owned or would claim mineral resources beyond 200 meters' depth on the continental shelf or even beyond the continental margin—which includes the shelf, the slope, and the rise—to the reaches of the deep ocean floor had to be faced.

President Johnson saw the dangers ahead and warned in 1966:

> Under no circumstances must we ever allow the prospects of a rich harvest of mineral wealth to create a new form of colonial competition among the maritime nations. We must be careful to avoid a race to grab and to hold the lands under the high seas. We must insure that the deep sea and ocean bottoms are to remain the legacy of all human beings.

Although the United States saw the problem, it had no over-all ocean policy and after the failure of the 1958 and 1960 Law of the Sea Conferences, the government was not eager to call for another international meeting to deal with seabed resources and related ocean problems.

Other nations also recognized the dangers ahead. In the autumn of 1967, Malta's United Nations Ambassador Pardo, in a speech before that body, informed the world community that rapidly developing technology made possible the exploration, occupation, and exploitation of the world's seabeds and much of its ocean floor. He warned of the incalculable dangers for mankind if rules to govern that exploitation were not agreed on before the scramble began, and asked the United Nations to draft a treaty to govern such exploitation. The treaty, Pardo said, should state that the seabeds and ocean floor, which at that time were beyond the limit of national jurisdiction, should not be subject to later appropriation. He asked that a new international agency be given jurisdiction over the area and that the riches derived therefrom be used primarily to aid developing countries.

In 1968, the U.N. General Assembly established a Seabed Committee to study the matter, and in subsequent years the Assembly adopted resolutions declaring that seabed resources beyond national jurisdictions were the common heritage of mankind; and that all states and private corporations were forbidden to exploit those resources until a new international system governing their control could be established.

The United States government, particularly the Department of State, seeing the growing movement for a new law of the sea conference, worked quickly to develop its own policy so that a U.S. draft convention could set the framework of the coming debate. The new policy, announced by President Nixon on May 23, 1970, proposes that all national claims over the natural resources of the seabed beyond 200 meters' depth be renounced and that such resources be regarded as the common heritage of mankind under the jurisdiction of a new international agency. The President urged all nations to adopt as soon as possible a treaty embodying those principles. He also proposed that the treaty establish rules to prevent unreasonable interference with other uses of the ocean, protect the seas from pollution, and provide for peaceful and compulsory settlement of disputes. These farsighted proposals were bitterly criticized by some interests, the oil industry in particular, which branded the policy a "giveaway." The industry felt that under the 1958 Geneva continental shelf convention, the United States already had rights to resources far beyond 200 meters in depth, in fact to the edge of the continental margin at the beginning of the deep ocean floor.

After considerable discussion in the fall of 1970, the U.N. General Assembly called for a comprehensive international law of the sea conference for 1973 (later postponed until 1974). To assure the success of that conference, the U.N. Seabed Committee, composed of more than ninety member countries, was given the interim job of drawing up a draft on which participating members could agree beforehand. Between 1971 and 1973 the Seabed Committee convened six times, for a total of more than forty weeks. At those meetings, the United States put forward five detailed proposals that may become the basis of the final settlement. They deal with seabeds, the breadth of the territorial sea, transit through straits, living resources, and control of pollution from vessels.

The U.S. proposal for the seabeds would divide the ocean floor into three basic jurisdictions. Coastal states would maintain their rights to the natural resources on the seabeds up to a depth of 200 meters or, alternatively, to a given number of miles—perhaps twelve or fifty—from the shore.

An intermediate zone, either from 200 meters' depth to the end of the continental margin or out to 200 miles, would also be established under an international agency. The coastal state would manage seabed resources in this intermediate zone, licensing exploration and exploitation. But that management would be subject to international standards and review, including conformity to environmental agreements. The U.S. proposal calls upon the coastal state to share part of the revenue derived from exploitation of resources in the zone with the international community. Such revenue would be used for the economic advancement of all developing countries, coastal and landlocked.

Beyond the continental margin, or 200 miles, the deep seabed would be under the jurisdiction of an International Seabed Resource Authority, which would have rights and duties similar to those of the control agency in the intermediate zone. It is not anticipated that much petroleum or natural gas will be discovered beyond the continental margin, and thus the seabed authority would, for the most part, regulate recovery of the manganese nodules, whose commercial exploitation may be feasible by 1980.

Concerning the breadth of the territorial sea, the United States has adhered to a three-mile territorial limit for almost two centuries, but the claims of other states vary widely, ranging to a maximum of 200 miles. There is a clear need for a uniform territorial sea. The general sentiment in the international community is that it should be somewhat broader than three miles. The United States has proposed, therefore, that the maximum breadth of the territorial sea be set at twelve miles, contingent upon acceptance of the U.S. position on international straits.

Since many straits used for international navigation are less than twenty-four miles wide and thus would be completely overlapped by a twelve-mile territorial sea, the United States has put forth, as a condition to its agreement to a twelve-mile territorial sea, a provision for a new right of "free passage and overflight" in straits. This provision is believed essential because the ill-defined doctrine of "innocent passage" would otherwise apply, enabling states bordering straits to decide which ships and planes could or could not pass.

The U.S. proposal on living resources, or fisheries, recognizes that to achieve a general international agreement on a twelve-mile territorial sea, coastal states must be given fishing jurisdiction beyond twelve miles. Based on the so-called species approach, the United States proposes that coastal states be given management authority over coastal species and anadromous fish (such as salmon, which spawn in internal waters but range thousands of miles offshore during their life cycle). Management of highly migratory fish, such as tuna, would be left to international bodies. Within the coastal fishing zone, which may extend to 200 miles, the United States believes that international standards of conservation should apply.

On the subject of control of pollution from vessels, and to avoid a patchwork of differing environmental standards regulating vessel use in areas under each nation's jurisdiction, the United States has proposed that the International Maritime Consultative Organization, an existent U.N. specialized agency, adopt international standards on vessel construction and use, and that these standards be enforced by coastal, flag, and port states.

The U.S. proposals, as might be expected, have not met with universal acceptance. Many developing countries tend more and more to depend on government enterprises in the extractive industries, and a number of them are supporting the proposal for an International Seabed Resource Authority sponsored by several Latin American states. This exclusive operating agency would have an absolute monopoly on the exploration, exploitation, and marketing of deep seabed mineral resources. The private or state-owned corporations of the developed nations would play no role in the exploitation except under service contracts entered into with the international agency.

Other developing nations, such as Bolivia, Zaïre, Zambia, and Singapore, propose that the international authority, even if it does not have exclusive jurisdiction, should have control over the marketing of deep seabed mineral wealth. This would protect the economies of those nations dependent on mining industries that produce the same minerals found on the seabeds.

The United States, the USSR, and other developed countries have indicated that they cannot agree with these proposals of the developing nations, nor with their suggestion that the international authority be governed on a "one nation, one vote" basis, without recognition being given to the power and influence of the industrialized nations.

Spain, the Philippines, and Indonesia have led the opposition to the U.S. proposal for "free transit through and over" international straits that will be overlapped by territorial seas if these are extended to twelve miles. It is argued that the United States and the USSR, which supports the U.S. proposal, want the provision so that the mobility of their armed forces to intervene throughout the world will remain unimpaired. Many Latin American countries, which now support Spain in this matter, realize that the United States will be more apt to agree to their proposal for expanded coastal state jurisdiction over seabed resources and fisheries if, in return, they support the U.S. straits position. The United States, of course, believes "free transit" through straits is essential to assure the mobility of its nuclear deterrent submarine force.

The USSR and Japan have offered proposals allowing their distant-water fishing fleets to take fish within a coastal state resource zone if that state is not utilizing them. Many developing states, on the other hand, want their fishing jurisdiction to be exclusive—with no residual rights left for the distant-water fishing fleets. The U.S. proposal, as stated above, attempts to bridge these differences.

Despite their numerous shortcomings, the U.S. proposals, on the whole, do attempt to deal with the problems mankind faces in establishing order in the oceans, and they make a serious effort to accommodate the varied and often conflicting interests of the different nations of the world.

If the Law of the Sea Conference, which will begin substantive work in 1974, should fail, it is expected that industries in the developed countries would urge their respective governments to make bilateral agreements on rules governing resources beyond national jurisdictions, so that exploitation of those resources could begin forthwith. Since the developing countries believe the resources in question are the common heritage of mankind, bitter feelings, a poisonous political atmosphere, and a further polarization of relations between developed and developing nations would surely follow, with unforeseen results. If, on the other hand, the international community can develop new and effective law and institutions for the oceans, the precedent could lead to a greater reliance on international institutions for the settlement of other disputes and possibly to a general easement of international tension. □

Continued from page 86

subject fascinated him; he obtained seeds from Gray, raised the plants, and became enmeshed in analyzing the revolving movements of tendrils and stems. Through a period of ill health, he continued these investigations and in 1864, sent a long paper on climbing plants to the Linnean Society, a prestigious British botanic group founded in the eighteenth century. In 1875, the paper was revised and published as a separate book, *The Movements and Habits of Climbing Plants*. Then in 1880, aided by his son Francis, who had worked for a year in Germany with the famous plant physiologist Julius Sachs, Darwin wrote *The Power of Movement in Plants*, a book that has considerably influenced modern plant physiology.

Darwin carefully observed the movements of growing plants by devising some homemade laboratory equipment. He would attach a slender glass filament, whose end had been dipped in a bright pigment, to a plant tip to amplify its movements. Then, placing a glass plate over the plant, he made dots on the glass to mark each new tip position. By connecting the dots, he obtained a continuous recording of the plant's movements, which he called circumnutation.

After studying the movement of plants in the absence of any external stimulus, Darwin initiated a detailed study of the effects of gravity and light on plant movements. Exposing young seedlings of the grass family to unilateral light, he noted an alteration of the usual circumnutational pattern and a bending of the plant toward the light (phototropism). By covering the seedling with a minutely scored, dark-lacquered glass shield through which pinholes of light were transmitted, Darwin ascertained that only the extreme tip of the grass could perceive the light energy, while cells that were some distance from the tip were responsible for the actual curvature. He therefore postulated the existence of some mechanism for the transmission of the light stimulus from one plant part to another.

Concerning the response of plants, especially their roots, to gravity, a reaction referred to as geotropism, Darwin noted that removal of the tip would annul further response.

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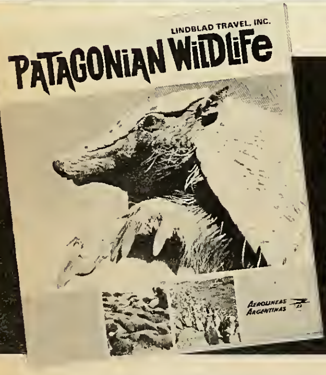

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The fact of the tip alone being sensitive to the attraction of gravity has an important bearing on the theory of geotropism. Authors seem generally to look at the bending of a radicle towards the center of the earth as the direct result of gravitation, which is believed to modify the growth of the upper or lower surfaces in such a manner as to induce curvature in the proper direction. But we now know that it is the tip alone which is acted on, and that this part transmits some influence to the adjoining parts, causing them to curve downwards. Gravity does not appear to act in a more direct manner on a radicle, than it does on any lowly organized animal, which moves away when it feels some weight or pressure. . . . It is hardly an exaggeration to say that the tip of the radicle thus endowed, and having the power of directing the movements of the adjoining parts, acts like the brain of one of the lower animals; the brain being seated within the anterior end of the body, receiving impressions from the sense organs, and directing the several movements.

These statements created a storm among plant physiologists, especially in Germany. Most investigators thought it necessary to try to disprove Darwin's observations, and many papers were published to show that the tip was no more sensitive to light and to gravity than the rest of the growing stem. However, thirty years later, Prof. Peter Boysen-Jensen in Copenhagen initiated experiments on localized phototropic perception that confirmed Darwin's hypothesis. The tip did indeed control the growth of the subjacent region through some influence that moved downward. This influence, presumably chemical, could pass through a wound and even through an aqueous gelatin barrier, but was stopped by a mica or metal barrier. Its distribution was symmetrical in unstimulated plants, but asymmetrical in unilaterally light-stimulated plants. These findings led in 1928 to the discovery by Frits Went in Utrecht of *auxin*, the first defined, mobile chemical stimulus in plants. Went made this discovery while still a graduate student.

The fact that the extracted and chemically characterized *auxin* satisfactorily explained the influence of the tip on subjacent regions established plant hormone studies as an important part of experimental botany. This field has continued to grow and now dominates modern agriculture. Virtually no agricultural product is produced today without some help from a plant hormone or a synthetic analog. Such substances control almost all phases of plant life, including seed germination, stem growth, root initiation, bud and seed dormancy, flower formation, fruit set, fruit ripening, senescence, and leaf fall, or abscission.

Darwin's work, carried out only to satisfy his consuming interest in plants, has thus had profound practical applications for agriculture. Had he been working for some chemical company and been instructed to produce a herbicide, a fruit ripener, an abscission or antiabscission agent, he might or might not have been able to do so. But his fertile imagination, sharp powers of observation, and experimental virtuosity led him to many important discoveries.

It is characteristic of Darwin that he was not satisfied with his own accomplishments. He says of himself:

> My mind seems to have become a kind of machine for grinding general laws out of large collections of facts, but why this should have caused the atrophy of that part of the brain alone, on which the higher tastes depend, I cannot conceive. A man with a mind more highly organized or better constituted than mine, would not, I suppose, have thus suffered; and if I had to live my life again, I would have made a rule to read some poetry and listen to some music at least once every week; for perhaps the parts of my brain now atrophied would thus have been kept active through use. The loss of these tastes is a loss of happiness, and may possibly be injurious to the intellect, and more probably to the moral character, by enfeebling the emotional part of our nature.

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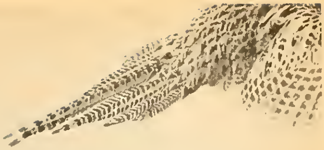
Columnist Arthur W. Galston teaches biology at Yale University.



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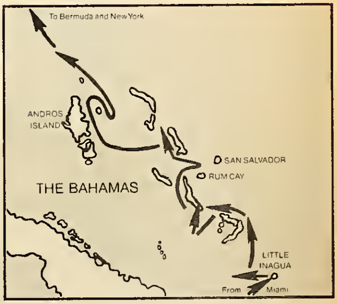

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Pots and Robbers

The Plundered Past, by Karl E. Meyer. *Atheneum, $12.95; 353 pp., illus.*

As never before, the earth is under pressure to yield up its resources, a statement whose force we may literally feel if the winter turns hard. As a consequence we are rapidly learning to care about such questions as how our earth's resources are obtained and what use is made of them. Now this is beginning to be true of another nonrenewable resource, the world's archeological heritage; for here, too, a point of crisis has been reached.

Although the serious menace to future archeological research posed by illicit excavation has been discussed a good deal in the press and in various journals in recent years, no comprehensive review of the subject has been available. Now Karl Meyer's book appears and serves this purpose very well.

Meyer, who is an investigative journalist as well as an archeology aficionado, has obviously put an immense amount of energy into unraveling the antecedents of several important objects recently purchased by museums and private collectors, following as far as possible the devious routes such objects take in reaching their destination. He has examined the motives of collectors and museum officials and has considered what steps could be taken to control the trade. All this he accomplishes in urbane style and with sufficient detachment, even though an underlying sense of outrage is apparent.

In this book, considerable attention is given to the area in which I myself am concerned as an archeologist: the Maya area, where the crisis has developed very rapidly. It is no more than a dozen years since the first disquieting symptoms began to appear, and now the prognosis is desperate, if not terminal. To be sure, there were earlier, isolated cases of illegal removal of monuments and some desultory dig-

Dietrich von Bothmer of the Metropolitan Museum of Art is seated beside the calyx krater painted by Euphronios. Italian police believe the vase was illegally excavated from an Etruscan tomb.

ging, but one felt no great economic force behind these activities, no market trend that seemed unstoppable and all devouring.

In common with so many lands of ancient high cultures, the territory of the Maya in Guatemala and southeastern Mexico has not enjoyed the material prosperity of industrialism. Most of the region is, in fact, covered with jungle and accessible only to travelers on foot. Within the last decade a few roads have been built, and settlers have cleared off the forest in some areas, disclosing ancient mounds in the process. But in general this sudden burst of despoliation cannot be attributed to any change in the internal situation. The denizens of that wilderness have always been poor, always a little contemptuous of government regulations, and some, no doubt, would always have been willing to help satisfy a world demand for their local antiquities, had it existed.

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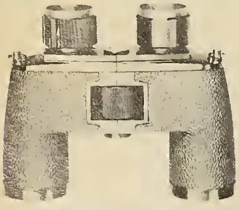

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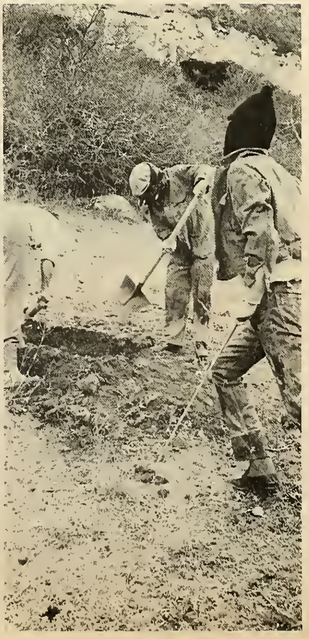
ing through the forest on the trails kept open by the chicle gatherers could not help but see that excavators had also recently been that way. One can hardly find a ceremonial group that has not been damaged by looters' pits and tunnels. Any sculptured stones that stood among the temples, would also have received attention.

It was about ten years ago that I, for one, first made two observations about the looting business in the central Maya lowlands. One was the evident arrival of trained excavators on the scene—former workers, probably, on the Tikal project of the University of Pennsylvania. One began to see nice rectangular pits instead of conical holes. Sometimes poles had been set at the front corners of a mound, testifying to an attempt to find the center-line before starting a tunnel in search of a

Three Italian tomb robbers busily dig at what they hope will prove a lucrative Etruscan site.



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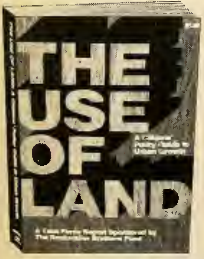

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tomb. The other thing I noticed was that soon after a Maya relief had been sold to a well-known collection for $60,000, any chicle gatherer one spoke to about a stela would give his opinion that it must be worth $60,000. Word of the sale had spread.

As a consequence, the removal of carved monuments ceased to be the monopoly of well-organized bands, and a wide divergence in stela-cutting skill became apparent. Neat slicing of sculpture one could attribute to an operator working in cahoots with a well-established dealer, whereas a crude job of cracking up a stela by means of fire or hammer blows would indicate local initiative: some chicle or lumber worker anxious to get in on a good thing, in spite of total lack of expertise and equipment.

Operators of the one sort, however, often show no better discernment than the other in choosing their objectives. Many times I have seen sculptures of negligible commercial value, even when intact, clumsily reduced to fragments. Sometimes the fracturing has turned out so badly that the whole mess has been abandoned; in other cases the nearly worthless pieces have been taken away, probably never to reappear in any collection. At the other end of the scale of expertise, I cite an example that I came across this year at an unrecorded site in Guatemala: a stela neatly sawed into cubes, each of which had the sculptured surface sliced from it. As I interpret the evidence, the foreman of the sawing team must have sent the sculpture cut from the surface of just one block to his distant patron, while he went on with the other monuments at the site. Eventually, he probably received word that the stone was too eroded, and it was therefore junked. So, at the cost of considerable effort, I was able to reconstruct the whole stela—excepting, of course, the area corresponding to that one block—from the fragments, which had by then suffered further breakage.

Unpleasant scenes of this kind give the lie to the argument commonly put forward by those who would justify the trade in such sculpture, namely that they are performing a public service by insuring the preservation of sculpture that

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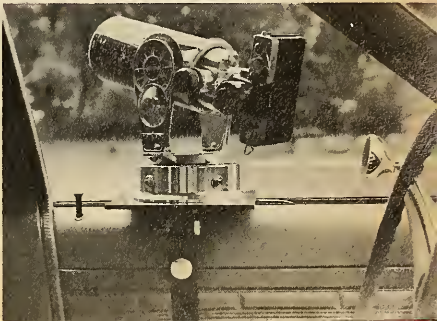

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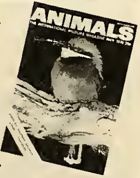

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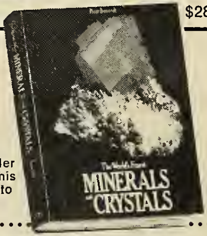

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would otherwise rot away in the jungle. In reality, few of the pieces that reach museums by this route have ever arrived complete. If the stela had a hieroglyphic inscription down the sides or back, then this would have been sacrificed when the shaft was reduced in bulk for removal, or the top and bottom may have been trimmed off.

The passions that drive people to collect are complex, poorly understood, and vary widely. As Hale White discreetly wrote nearly a century ago, "Men should not be too curious in analyzing and condemning any means which nature devises to save them from themselves, whether it be coins, old books, curiosities, butterflies, or fossils." The thrill of the chase and love of beauty are two obvious motives; others may be the desire for status and the healthy tax deduction that can be earned by gifts to museums. Meyer inquires at some length into the compulsive buying habits of museum managements and private collectors, who find themselves beleaguered nowadays when they are active in the field of antiquities. (Only the art funds, those mausoleums given up to the appreciation of art in the strict Wall Street sense, escape censure by reason of their positively subterranean profile.) And it really is difficult to understand how collecting in this area can be reconciled with a good conscience, when it endangers the very future of scientific excavation and, in the case of Maya sculpture, reduces the probable degree of success in decipherment of the writing. Can the collector who is concerned about the destruction of archeological evidence sincerely believe that every item he buys was found in a cave or was picked up by a peasant in his cornfield, romantic though the notion may be?

It does seem that a degree of self-deception is employed. Let me give two examples. In a municipal museum in Germany there is displayed the front surface of a stela that is known from the first reporting of it to have had hieroglyphs on the sides, although they were never photographed. When I expressed my dismay to the curator, and went on to stress the obvious point that more texts would make progress in decipherment more likely, the answer I received was that there are

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already quite enough hieroglyphs published for anyone to work on. And then, I have recently exchanged views with a prominent collector on the East Coast and find that the criterion he is content to use is whether or not a piece was properly purchased from Mexican individuals; he comes up with the interesting paradox that American private collectors pay for these objects and also keep them in private hands where more people can handle them and appreciate them.

When sensitivity to the consequences of collecting in this area lags so far behind the evolving ethical standard (and evolution has indeed been rapid), then it is a valuable service to expound the situation in a book such as the one under review. But if the problem is to be solved, a concerted attack will have to be made on several fronts: stricter control in the countries of origin, with policing of the more important ruins and perhaps electronic surveillance of others; the law changed in those countries to permit export or long loans or exchanges of pieces that are near-duplicates of masterpieces held in the national museums; voluntary restraint by collecting institutions; and the granting of tax benefits only for the gift of objects that have been obtained in a demonstrably legitimate manner (a ploy that I believe Mr. Meyer does not mention).

The Plundered Past is a handsomely produced book, although I have a perhaps idiosyncratic dislike for the bulked-up paper that makes it fatter than need be. There is a very impressive and useful bibliography, as well as appendices setting forth various resolutions and conventions. It is my belief that the long list of stolen easel paintings could have been omitted, as not relevant to the main theme of the book; also the verbatim transcript of an NBC "Today" show, starring Mr. Hoving and the Euphronios Pot, in spite of the touch of light relief that it provides.

Mr. Graham has spent fifteen seasons recording sculpture in the Maya areas of Guatemala and Mexico. He is research fellow in Middle American Archeology at Peabody Museum, Harvard University, and is currently engaged in compiling the corpus of Maya hieroglyphic inscriptions.

Collector Norton Simon has spent a fortune on Asian art—most of which, he admits, was smuggled.

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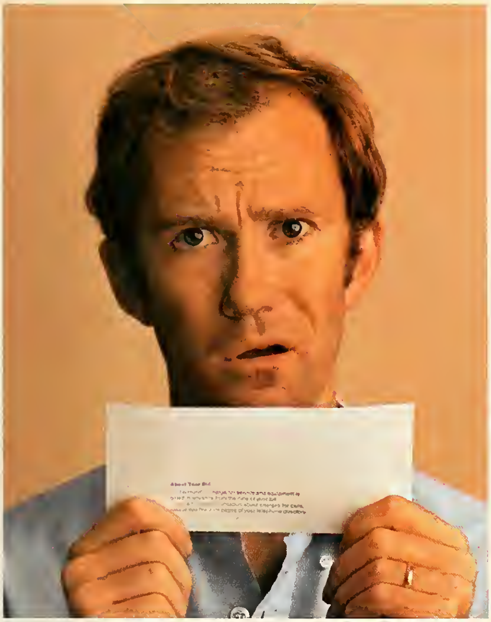

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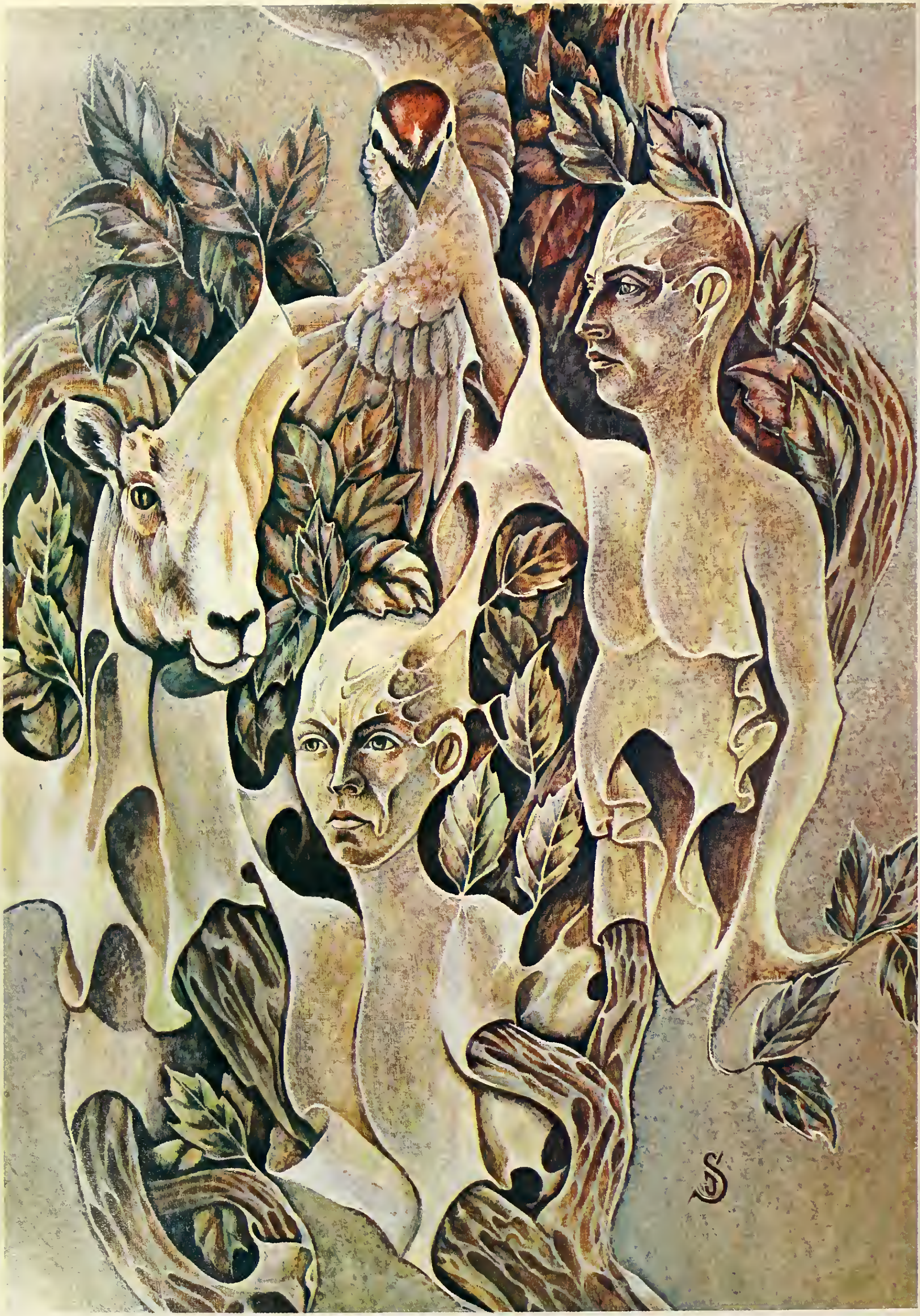

JOSEPH SCROFANI

The Hospitable Planet Earth

For the last few years ecologists have stressed how delicately humans are perched in their ecological niche. Stephen Dole, a systems analyst, has considered this problem on an even grander scale: how, from the very beginning, basic planetary physics determined the roles life could play on earth.

Although the physical evolution of the earth is not fully understood, Dole has applied what we do know to various "model earths" that differ slightly from our familiar planet. Suppose, for example, that when the solar system was formed, the earth had accumulated twice its present mass, altering its density and giving it a surface gravity 1.38 times normal. This increase in mass and gravity would squeeze the interior more, heating it to higher temperatures and forcing lava to percolate more readily upward. In turn, the quickening flow of gases and water vapor from volcanoes would produce a thicker atmosphere and larger oceans. The air would probably not be substantially different; the primordial atmosphere of methane, ammonia, and carbon dioxide would have eventually evolved, in concert with plant life, to its present state. Marine life would also have developed along the lines we know, but with more water forced to the surface through volcanoes, the oceans would grow. Our continents would shrink; perhaps there would be only scattered island chains.

To offset the increased gravity, plants would be shorter and trees would have thick trunks and stubby branches. Short, stout land animals with large feet would probably play the same basic roles we know. But birds might not have evolved at all, since the ability to fly is based on a delicate balance of gravity, air density, and the amount of bone necessary to support the bird.

Even the appearance of the land would be changed. Since they would exceed their structural support, mountains could not thrust so high. Water would fall faster, hastening erosion and carving deep canyons and gullies. Ocean waves would be shorter and clouds lower. Other things, such as the composition of the earth's crust, size of the ice caps, period of the moon, and the earth's magnetic field would be changed. Certainly, even if most of the accidents of evolution were repeated, the resultant humans would be substantially different from ourselves. They would be short, stocky, more muscular, and probably less graceful; more subtle changes in behavior and outlook would follow.

Turning the problem around, what if earth had evolved with half its present mass? With a surface gravity of 0.73 g., there would be less water produced by volcanic action, a thinner atmosphere, reduced erosion (because water would not fall as fast), and probably a greater profusion of bird life. Animal skeletons would be lighter, trees taller, and, again, humans would certainly be different. They would be taller, with smaller feet. They might even have evolved to use trees and ground jointly as their ecological niche, instead of specializing as foraging land creatures.

Many aspects of planetary physics would make for even greater differences. For example, the earth's axis is inclined at an angle of 23.5 degrees to the plane of its orbit around the sun. This gives us our winters and summers, as one hemisphere or the other is successively turned toward the sun. What if this angle were increased? If the angle were 60 degrees, but day length the same, seasonal weather changes would be intolerable. Men could live only in a narrow belt within 5 degrees of the Equator; during most of the year the rest of earth would be too cold or too hot. Life might do fairly well in the oceans, but it would not evolve rapidly and successfully on land.

Conversely, changing the angle of inclination to zero degrees would not have influenced matters greatly. There would be no seasons; weather would be humdrum and boring. Near the Equator, the temperature would be considerably higher than it is now, and people would avoid living near it. The poles, however, would be warmer and men could live closer to them.

Our climate is critically determined by the amount of sunlight that reaches the surface of the earth. To illustrate how precarious the balance is, suppose the earth were 10 percent closer to the sun (which would probably alter our atmospheric evolution, too, but for simplicity we'll neglect that complication). Even this small change would mean that only 20 percent of the world would be inhabitable by humans. The Equator would be a torrid, impassable band around the planet, leaving only two narrow regions near the poles where man could live.

Evolution on the land could even proceed independently in the two regions. Specialized land forms, which could fly high over the Equator and thus make use of both regions, might evolve, but overland travel would be impossible. Conceivably, man could evolve in one region and develop an entire civilization without knowing that there was another half of a planet available to him. (This situation would be roughly comparable to what happened in our history—until 500 years ago most of civilization knew nothing of the Americas.) The livable land of this hotter earth, however, would be scarce, because polar caps would not have formed, resulting in larger oceans.

We could also toy with earth's day. A shorter day, say, three hours, would not make much difference in the habitability of our planet. It would, however, have interesting side effects—warmer nights and cooler days, probably more tumultuous weather, higher winds, and, because of the higher angular velocity of rotation, a slight apparent change in gravity between the Equator and the poles.

Making the day longer, 100 hours for example, would be disastrous. Few forms could live on land, because they would roast in the day or freeze at night.

It is not surprising that the changes investigated are all for the worse. We have evolved to fit our world, just the way it is, and no other planet—hypothetical or otherwise—is likely to suit us as well. ☐

Celestial Events

by Thomas D. Nicholson

Sun and Moon The sun arrives at the winter solstice, in the constellation Sagittarius, at 7:08 P.M., EST, on December 21, marking the end of autumn and the beginning of winter in the Northern Hemisphere. The several weeks in late December bring the shortest days and longest nights of the year. In the middle latitudes of the United States, the sun remains above the horizon for only about 9 hours 20 minutes. On January 4, the earth arrives at the point in its elliptical orbit known as perihelion and is nearest to the sun for the year. With last-quarter moon on December 16 and new moon on December 24, we can expect dark, moonless nights in late December until the early evening crescent becomes visible about December 27. From then on, the moon will be progressively larger, brighter, and more prominent through first-quarter on January 1 and full moon on January 8. In its waning cycle thereafter, the moon will be at last-quarter on January 15.

Stars and Planets Winter stars are now at their best, well up in the east at dusk and remaining in the sky till dawn. No part of the sky has brighter or more colorful stars. Even so, their brightness is eclipsed this winter by four brilliant planets in the early evening sky. From west to east (right to left as you face south), they are Venus, Jupiter, Mars, and Saturn. Venus, the brightest planet, and Jupiter will be quite close in the sunset sky through late December and early January, and both will set an hour or so after twilight ends. Mars is high in the east, in the stars of Aries, and sets after midnight. Saturn, rising with Gemini, remains in the sky all night.

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HYDRA
Alphard

Comet Kohoutek In late December the comet will be lost to view as it approaches close to the sun. For several weeks, it will be above the horizon only in daylight. After it passes the sun on December 28, however, the comet will swing to the left of the sun and into the evening sky. If predictions as to its brightness are correct, it should be visible after sundown in early January, low in the southwest, with its tail extending upward and away from the sunset glow. It should become higher and more prominent nightly as it moves away from the sun, but it will fade gradually as it becomes more distant from the sun and the earth.

December 19: Venus is at greatest brilliancy in the evening sky.

December 21: Winter begins in the Northern Hemisphere.

December 22: The Ursid meteor shower reaches maximum.

December 23: Saturn is at opposition from the sun, rising at sundown, setting at sunrise.

December 24: A partial eclipse of the sun will be visible at, or shortly after, sunrise in central and eastern United States and Canada. It will be an annular eclipse in northern South America and western Africa.

December 27: Venus and Jupiter are close to the crescent moon this evening.

January 1: Venus begins its retrograde motion on the way to inferior conjunction with the sun later this month.

January 2-3: Mars is near the moon on both evenings.

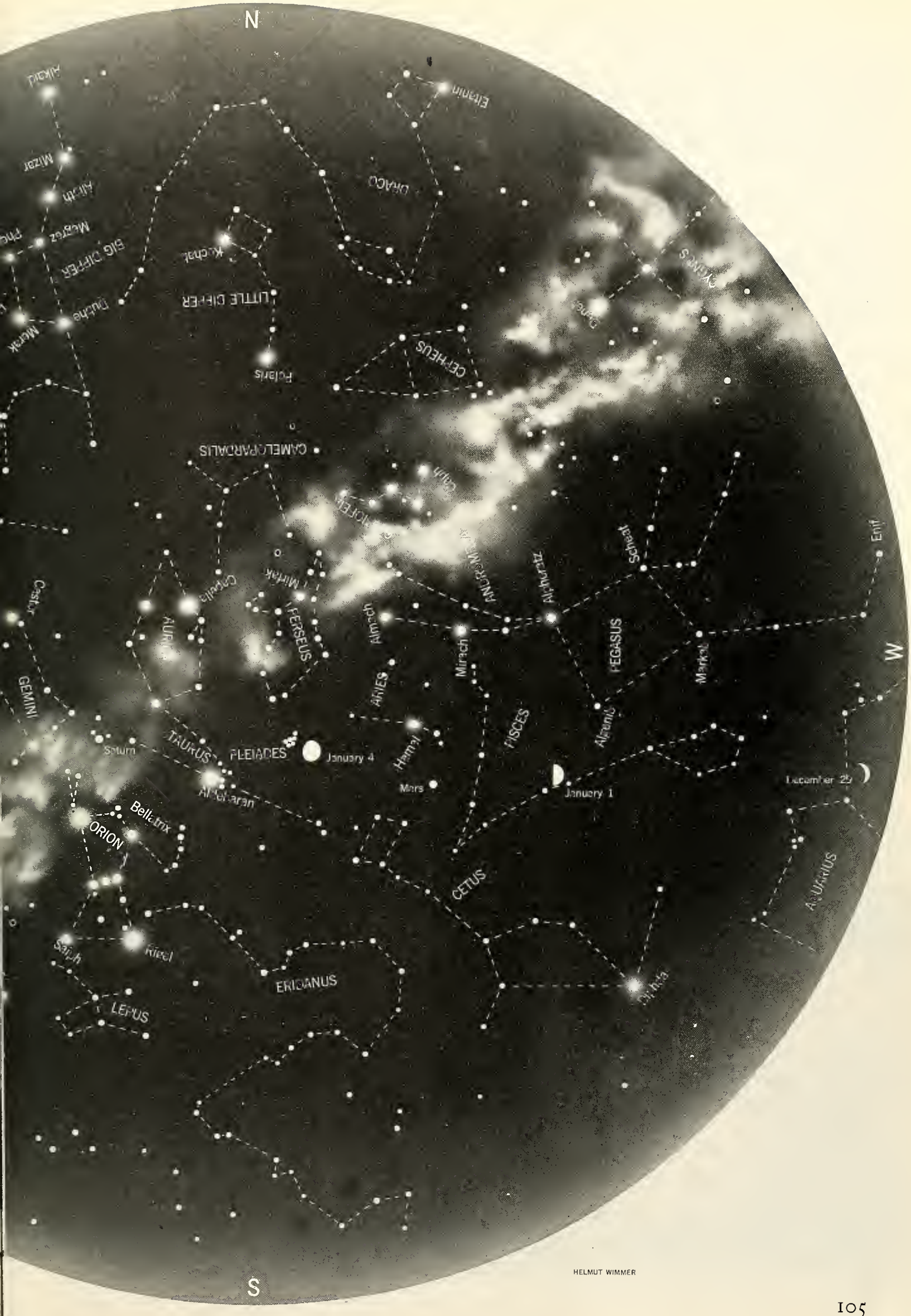
January 4: Earth is at perihelion, nearest the sun.

January 6: Saturn is near the moon this evening.

January 8: Perigee spring tides occur today, with exceptionally high water levels at high tides.

January 9: Mercury is at superior conjunction and enters the evening sky.

★ Hold the Star Map so the compass direction you face is at the bottom, then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:20 P.M. on December 15; 9:15 P.M. on December 31; and 8:15 P.M. on January 15; but it can be used for about an hour before and after these times.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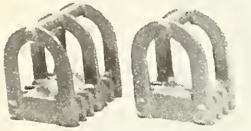

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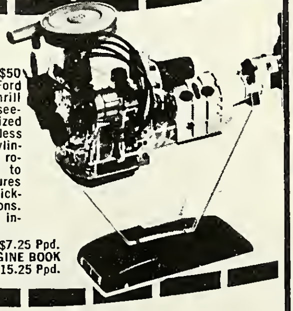

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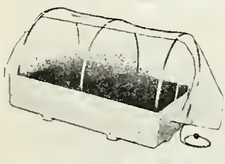

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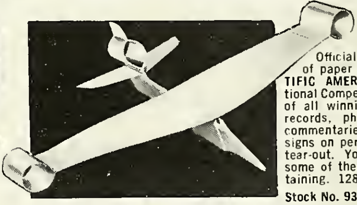

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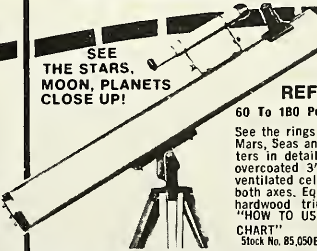

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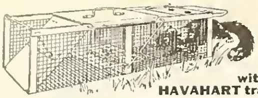

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LIVING OFF THE FUELS OF THE LAND

ENERGY. J. Holdren and P. Herrera. Sierra Club Books, San Francisco, 1971.

DIET FOR A SMALL PLANET. F. M. Lappe. Ballantine Books, Inc., New York, 1972.

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LIFE BETWEEN TIDEMARKS ON ROCKY SHORES. T. A. Stephenson and A. Stephenson. W. H. Freeman and Company Publishers, San Francisco, 1972.

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THE JEWISH WAR. Josephus. Penguin Books, Baltimore, 1972.

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MEN AND PANDAS. R. Morris and D. Morris. McGraw-Hill, Inc., New York, 1967.

THE GIANT PANDA. D. D. Davis. Fieldiana Zoology Memoirs, 3, 1964.

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GODS, GHOSTS AND MEN IN MELANESIA. P. Lawrence and M. J. Meggitt, eds. Oxford University Press, New York, 1965.

ROAD BELONG CARGO. P. Lawrence. Humanities Press, Inc., 1967.

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THE FUTURE OF THE OCEANS. W. Friedmann. George Braziller, Inc., New York, 1971.

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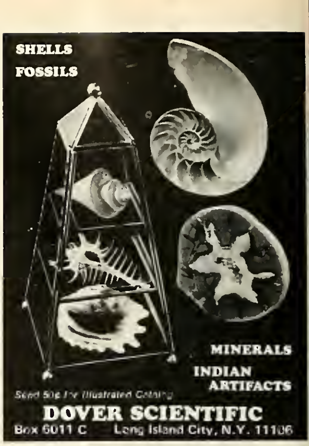

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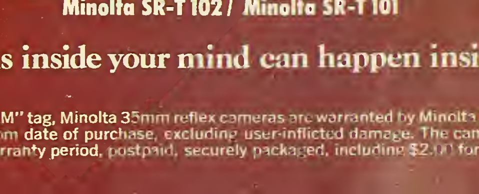

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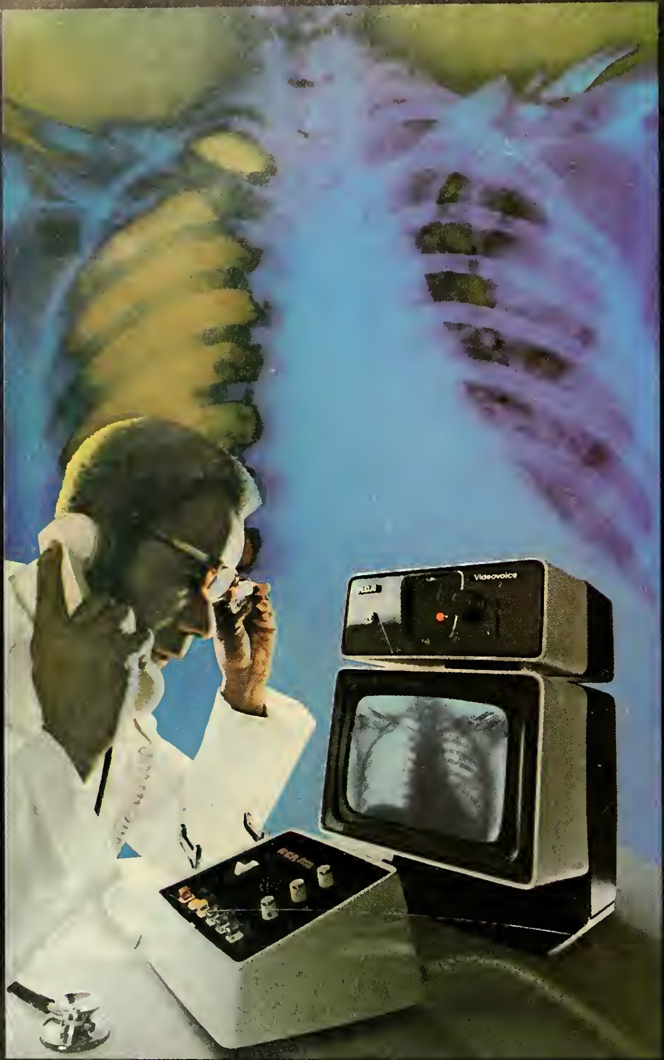

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